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# DEPARTMENT OF ENERGY FISCAL YEAR 1983 NATIONAL DEFENSE PROGRAMS AUTHORIZATION

## HEARING

BEFORE THE

## SUBCOMMITTEE ON STRATEGIC AND THEATER NUCLEAR FORCES

OF THE

## COMMITTEE ON ARMED SERVICES
## UNITED STATES SENATE

NINETY-SEVENTH CONGRESS

SECOND SESSION

ON

## S. 2286

TO AUTHORIZE APPROPRIATIONS FOR THE DEPARTMENT OF ENERGY FOR NATIONAL SECURITY PROGRAMS FOR FISCAL YEAR 1983 AND FISCAL YEAR 1984, AND FOR OTHER PURPOSES

APRIL 26, 1982

Printed for the use of the Committee on Armed Services

U.S. GOVERNMENT PRINTING OFFICE
99-371 O WASHINGTON : 1982

S201-36

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# DEPARTMENT OF ENERGY FISCAL YEAR 1983 NATIONAL DEFENSE PROGRAMS AUTHORIZATION

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**MONDAY, APRIL 26, 1982**

U.S. SENATE,
SUBCOMMITTEE ON STRATEGIC AND
THEATER NUCLEAR FORCES,
COMMITTEE ON ARMED SERVICES,
*Washington, D.C.*

The subcommittee met in executive session, at 10:25 a.m., pursuant to notice, in room 212, Russell Senate Office Building, Senator John W. Warner (chairman) presiding.

Present: Senators Warner, Thurmond, and Jackson.

Staff present: George K. Johnson, Jr., Patrick L. Renehan, and James C. Smith, professional staff members; and Marie Fabrizio Dickinson, staff assistant.

Members' assistants present: Buzz Hefti, assistant to Senator Warner, and Frank Krebs, assistant to Senator Cannon.

[The bill S. 2286 follows:]

**[S. 2286, 97th Congress, 2d Session]**

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**A BILL To authorize appropriations for the Department of Energy for national security programs for fiscal year 1983 and fiscal year 1984, and for other purposes**

***Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,*** **That this Act may be cited as the "National Security Programs Authorization Act for Fiscal Years 1983 and 1984".**

## TITLE I—NATIONAL SECURITY PROGRAMS

### OPERATING EXPENSES

SEC. 101. Funds are authorized to be appropriated to the Department of Energy for fiscal year 1983 for operating expenses incurred in carrying out national security programs (including scientific research and development in support of the armed forces, strategic and critical materials necessary for the common defense, and military applications of nuclear energy and related management and support activities) as follows:

**(1) For naval reactors development, $326,760,000.**
**(2) For weapons activities, $2,793,691,000.**
**(3) For verification and control technology, $52,400,000.**
**(4) For materials production, $762,900,000.**
**(5) For defense nuclear waste, $285,929,000.**
**(6) For nucelar materials security and safeguard development, $43,160,000.**
**(7) For security investigations, $26,000,000.**

### PLANT AND CAPITAL EQUIPMENT

SEC. 102. Funds are authorized to be appropriated to the Department of Energy for fiscal year 1983 for plant and capital equipment (including planning, construction, acquisition, and modification of facilities, land acquisition related thereto, and acquisition and fabrication of capital equipment not related to constructon) necessary for national security programs as follows:

(1) For naval reactors development:

Project 83–N–101, general plant projects, various locations, $1,500,000.

Project 83–N–102, additions to the radioactive materials laboratory, Knolls Atomic Power Laboratory, Schenectady, New York, $1,500,000.

(2) For weapons activities:

Project 83–D–101, general plant projects, various locations, $15,800,000.

Project 83–D–123, general plant projects, various locations, $16,300,000.

Project 83–D–124, standard missile-2 (SM–2) warhead production facilities, various locations, 7,000,000.

Project 82–D–106, weapons assembly facilities, Pantex Plant, Amarillo, Texas, $16,500,000 for a total project authorization of $40,000,000.

Project 82–D–107, utilities and equipment restoration, replacement, and upgrade, phase III, various locations, $151,800,000, for a total project authorization of $239,300,000.

Project 82–D–108, nuclear weapons stockpile improvement, various locations, $37,300,000, for a total project authorization of $52,300,000.

Project 82–D–109, 155-millimeter artillery-fired atomic projectile (AFAP) production facilities, various locations, $18,000,000, for a total project authorization of $53,000,000.

Project 82–D–111, interactive graphics system, various locations, $12,000,000, for a total project authorization of $21,000,000.

Project 82–D–146, weapons production and production support facilities, various locations, $50,000,000, for a total project authorization of $58,000,000.

Project 81–D–115, MX warhead production facilities, various locations, $30,000,000, for a total project authorization of $70,000,000.

Project 81–D–133, earthquake damage restoration, Lawrence Livermore, California, $1,500,000, for a total project authorization of $5,500,000.

Project 81–D–134, earthquake damage restoration, Sandia National Laboratories, Livermore, California, $1,700,000, for a total project authorization of $3,700,000.

Project 79–7–c, proton storage ring, Los Alamos National Laboratory, Los Alamos, New Mexico, $2,800,000, for a total project authorization of $21,800,000.

Project 78–17–d, steam plant improvements, Y–12 Plant, Oak Ridge, Tennessee, $1,500,000, for a total project authorization of $27,000,000.

(3) For materials production:

Project 83–D–135, general plant projects, various locations, $25,000, 000.

Project 83–D–136, plant engineering and design, various locations, $2,000,000.

Project 83–D–138, PUREX canyon and dissolver filter systems improvements, Richland, Washington, $4,250,000.

Project 83–D–142, fuel dissolver off-gas transfer and treatment system, Idaho Fuels Processing Facility, Idaho National Engineering Laboratory, Idaho, $7,600,000.

Project 83–D–147, pollution discharge elimination, Savannah River, South Carolina, $1,000,000.

Project 83–D–148, nonradioactive hazardous waste management, Savannah River, South Carolina, $1,000,000.

Project 82–D–124, restoration of production capabilities, phases II and III, various locations, $48,500,000, for a total project authorization of $174,500,000.

Project 82–D–126, reactor safety and reliability, various locations, $18,700,000, for a total project authorization of $61,600,000.

Project 82–D–136, fuel processing facilities upgrade, Idaho Fuels Processing Facility, Idaho National Engineering Laboratory, Idaho, $6,000,000, for a total project authorization of $46,000,000.

Project 82–D–201, special plutonium recovery facilities, F-chemical separations area, Savannah River, South Carolina, $10,000,000, for a total project autorization of $12,000,000.

Project 81–D–142, steam transfer header, Savannah River, South Carolina $10,400,000, for a total project authorization of $18,400,000.

Project 81–D–143 L-reactor upgrade, Savannah River, South Carolina, $19,000,000, for a total project authorization of $134,000,000.

(4) For defense nuclear waste:

Project 83–D–156, general plant projects, interim waste operations, various locations, $19,145,000.

Project 83–D–157, additional radioactive waste storage facilities, Richland, Washington $19,000,000.

Project 83–D–159, general plant projects, long-term waste management technology, Savannah River, South Carolina, $500,000.

Project 81–T–104, radioactive waste facilities improvements, Oak Ridge National Laboratory, Tennessee, $1,000,000, for a total project authorization of $21,000,000.

Project 81–T–105, defense waste processing facility, Savannah River, South Carolina, $30,000,000, for a total project authorization of $60,000,000.

Project 77–13–f, waste isolation pilot plant, Delaware Basin, Southeast, New Mexico, $110,800,000, for a total project authorization of $268,400,000.

(5) For nuclear materials security and safeguards development:

Project 83–D–175, general plant project, New Brunswick Laboratory, $500,000.

(6) For capital equipment not related to construction—

(A) for naval reactors development, $11,000,000;

(B) for weapons activities, $201,000,000;

(C) for verification and control technology, $1,500,000;

(D) for materials production, $87,500,000;

(E) for defense nuclear waste, $31,646,000; and

(F) for nuclear materials security and safeguards development, $3,700,000.

## TITLE II—GENERAL PROVISIONS

### REPROGRAMING

Sec. 201. Except as otherwise provided in this Act—

(1) no amount appropriated pursuant to this Act may be used for any program in excess of 105 per centum of the amount authorized for that program by this Act or $10,000,000 more than the amount authorized for that program by this Act, whichever is the lesser, and

(2) no amount appropriated pursuant to this Act may be used for any program which has not been presented to, or requested of, the Congress, unless a period of thirty calendar days (not including any day in which either House of Congress is not in session because of adjournment of more than three calendar days to a day certain) has passed after receipt by the appropriate committees of Congress of notice from the Secretary of Energy (hereinafter in this title referred to as the "Secretary") containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of the proposed action, or unless each committee before the expiration of the period has transmitted to the Secretary written notice to the effect that the committee has no objection to the proposed action.

### LIMITS ON GENERAL PLANT PROJECTS

Sec. 202. (a) The Secretary may carry out any construction project under the general plant projects provisions authorized by this Act if the total estimated costs of the construction project does not exceed $1,200,000.

(b) If at any time during the construction of any general plant project authorized by this Act, the estimated cost of the project is revised because of unforeseen cost variations and the revised cost of the project exceeds $1,200,000, the Secretary shall immediately furnish a complete report to the appropriate committees of Congress explaining the reasons for the cost variation.

### LIMITS ON CONSTRUCTION PROJECTS

SEC. 203. (a) Whenever the current estimated cost of a construction project which is authorized by section 102 of this Act, or which is in support of national security programs of the Department of Energy and was authorized by any previous Act, exceeds by more than 25 per centum the higher of (1) the amount authorized for the project, or (2) the amount of the total estimated cost for the project as shown in the most recent budget justification data submitted to Congress, construction may not be started or additional obligations incurred in connection with the project above the total estimated cost, as the case may be, unless a period of thirty calendar days (not including any day in which either House of Congress is not in session because of adjournment of more than three days to a day certain) has passed ~~after receipt~~ by the appropriate committees of the Congress of written notice from the Secretary containing a full and complete statement of the action proposed to be taken and the facts and circumstances relied upon in support of the action, or unless each committee before the expiration of the period has notified the Secretary it has no objection to the proposed action.

(b) Subsection (a) shall not apply to any construction project which has a current estimated cost of less than $5,000,000.

### FUND TRANSFER AUTHORITY

SEC. 204. To the extent specified in appropriation Acts, funds appropriated pursuant to this Act may be transferred to other agencies of the Government for the performance of the work for which the funds were appropriated, and funds so transferred may be merged with the appropriations of the agency to which the funds are transferred.

### AUTHORITY FOR CONSTRUCTION DESIGN

SEC. 205. (a) Within the amounts authorized by this Act for plant engineering and design, the Secretary may carry out advance planning and construction designs (including architectural and engineering services) in connection with any proposed construction project.

(b) In any case in which the total estimated cost for such planning and design exceeds $1,000,000, the Secretary shall notify the appropriate committees of Congress in writing of the details of the project at least thirty days before any funds are obligated for design services for the project.

### AUTHORITY FOR EMERGENCY CONSTRUCTION DESIGN

SEC. 206. In addition to the advance planning and construction design authorized by section 102, the Secretary may perform planning and design utilizing available funds for any Department of Energy national security program construction project whenever the Secretary determines that the design must proceed expeditiously in order to meet the needs of national defense or to protect property or human life.

### FUNDS AVAILABLE FOR ALL NATIONAL SECURITY PROGRAMS OF THE DEPARTMENT OF ENERGY

SEC. 207. Subject to the provisions of appropriation Acts, amounts appropriated pursuant to this Act for management and support activities and for general plant projects are available for use, when necessary, in connection with all national security programs of the Department of Energy.

### ADJUSTMENT FOR PAY INCREASES

SEC. 208. Appropriations authorized by this Act for salary, pay, retirement, or other benefits for Federal employees may be increased by such amounts as may be necessary for increases in benefits authorized by law.

### AVAILABILITY OF FUNDS

SEC. 209. When so specified in an appropriation Act, amounts appropriated for "Operating Expenses" or for "Plant and Capital Equipment" may remain available until expended.

## TITLE III—AUTHORIZATION OF APPROPRIATIONS FOR FISCAL YEAR 1984

SEC. 301. There are authorized to be appropriated to the Department of Energy to be available not earlier than October 1, 1983, such sums as may be necessary for fiscal year 1984 for programs set forth in this Act.

## OPENING STATEMENT BY SENATOR STROM THURMOND, PRESIDING

Senator THURMOND. The subcommittee will come to order.

We will proceed until the chairman of the subcommittee returns. I believe we have two witnesses this morning, Hon. Herman E. Roser, Assistant Secretary of Energy for Defense Programs, and Dr. Richard L. Wagner, Assistant to the Secretary of Defense for Atomic Energy.

Is there anyone else here to testify?

Mr. ROSER. Mr. Chairman, we have the laboratory directors from the three nuclear weapons laboratories. I would like to give them the opportunity to testify, very briefly, if that is agreeable to the committee.

Senator WARNER [presiding]. That will be all right. You may proceed.

## STATEMENT OF HON. HERMAN E. ROSER, ASSISTANT SECRETARY FOR DEFENSE PROGRAMS, DOE

Mr. ROSER. Thank you, Mr. Chairman. This may be a little off the record, but I would certainly like to commend to this subcommittee the nomination of Dr. Wagner, who was just heard. I would simply like to say that Dr. Wagner is an outstanding working colleague and has been for a number of years. We have worked very closely together since he came to Washington and I think he is a real asset not only to the Department of Defense but also to the relationship between the Department of Defense and the Department of Energy.

If it is not out of line, I certainly commend Dr. Wagner's nomination to this committee.

Mr. Chairman, I have submitted my prepared statement for the record. With your indulgence, I will briefly summarize that statement with some vugraphs.

Senator WARNER. The entire statement will go into the record and you may summarize.

Mr. ROSER. Very well. Thank you.

[The prepared statement of Herman E. Roser follows:]

### PREPARED STATEMENT OF HERMAN E. ROSER, ASSISTANT SECRETARY FOR DEFENSE PROGRAMS, DEPARTMENT OF ENERGY

#### INTRODUCTION

Mr. Chairman and Members of the Committee, I am pleased to have this opportunity to testify on behalf of the Agency's fiscal year 1983 budget request for those Atomic Energy Defense Activities under my cognizance as Assistant Secretary for Defense Programs, which include all of those activities except the Naval Reactors Program. These activities for which I am responsible are the Weapons Program which includes Inertial Fusion; our Verification and Control Technology effort; the Nuclear Material Security and Safeguards work; the Agency's Security Investigations function; our Nuclear Materials Production program and the Defense Nuclear Waste Management activities.

Before I begin to describe the tasks of great National importance underlying our budget request, I want to make a very important point. The budget transmitted to the Congress in February was based on meeting the requirements of the fiscal year 1981–1983 Nuclear Weapon Stockpile Memorandum (NWSM), which was our weapons program production authority, valid at the time this budget was prepared. Now, however, we have in place a new NWSM, approved by President on March 17, covering the new weapon production requirements in the fiscal year 1983–1997 timeframe.

[Deleted.] Accordingly, my testimony today will address our new programmatic instructions contained in the fiscal year 1983 NWSM Budget Amendment requests necessary for us to carry out those instructions.

### DEFENSE PROGRAMS OVERVIEW

### CHART 1

### DEFENSE PROGRAMS MISSION

Develop and maintain a capability to design, test and manufacture all U.S. nuclear weapons.

Develop and maintain a capability to produce all nuclear materials required for the U.S. weapons program and manage defense nuclear wastes.

Conduct a program to develop inertial fusion in support of the Nation's military needs.

Insure the protection, control and accountability of special nuclear materials and DOE facilities.

Develop and maintain a capability to assure verification of international arms agreements and to control the transfer of sensitive technology and equipment.

Execute a program to control the dissemination of classified information.

The mission of the Defense Programs organization is as shown here. All of these tasks support or otherwise contribute to or are derived from our primary function of research, design, testing, and production of our Nation's nuclear weapons.

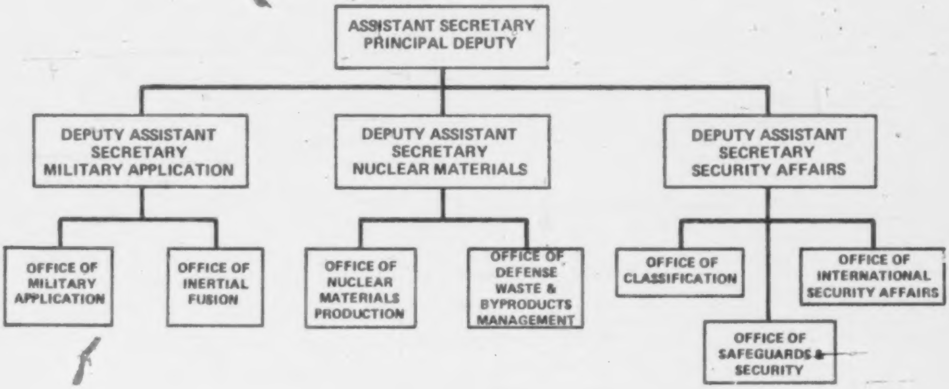

ASSISTANT SECRETARY
PRINCIPAL DEPUTY
DEPUTY ASSISTANT SECRETARY MILITARY APPLICATION
DEPUTY ASSISTANT SECRETARY NUCLEAR MATERIALS
DEPUTY ASSISTANT SECRETARY SECURITY AFFAIRS
OFFICE OF MILITARY APPLICATION
OFFICE OF INERTIAL FUSION
OFFICE OF NUCLEAR MATERIALS PRODUCTION
OFFICE OF DEFENSE WASTE & BYPRODUCTS MANAGEMENT
OFFICE OF CLASSIFICATION
OFFICE OF INTERNATIONAL SECURITY AFFAIRS
OFFICE OF SAFEGUARDS & SECURITY

CHART 2

Since the last time these programs were presented to this Committee, we have formalized a new organized structure, with three new Deputy Assistant Secretaries, one for Military Applications including Inertial Fusion, General Hoover, here; a Deputy Assistant Secretary for Nuclear Materials, Dr. Gilbert; and a

Deputy Assistant Secretary for Security Affairs, Mr. Culpepper. Those who were in an "acting" capacity at this time last year have now all been formally appointed to their respective positions. Further, at this time last year, the Nuclear Waste Management organization reported to the Assistant Secretary for Nuclear Energy on commercial matters and to the Assistant Secretary for Defense Programs on defense waste matters. Now, a new office of Defense Waste and Byproducts Management is in place under Dr. Gilbert, enabling our direct control over the management of Defense Waste and facilitating closer coordination with the Materials Production program, the source of most of the nuclear waste we manage.

ATOMIC ENERGY DEFENSE ACTIVITIES
FY 1983 BUDGET SUMMARY
(B/A $ in Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| WEAPONS ACTIVITIES | AUTH. AS ENACTED | APPROP. INCL. SUPPLEMENTAL | AUTH. AS AMENDED | APPROP. AS AMENDED |
| RESEARCH, DEVELOPMENT & TESTING | $1,108.2 | $1,103.3 | $1,191.8 | $1,191.8 |
| INERTIAL FUSION | 153.3 | 209.1 | 133.0 | 152.7 |
| PRODUCTION AND SURVEILLANCE | 1,797.6 | 1,626.9 | 2,062.5 | 2,121.0 |
| PROGRAM DIRECTION | 41.4 | 42.7 | 51.3 | 51.3 |
| SUBTOTAL WEAPONS | $3,100.5 | $2,982.0 | $3,438.6 | $3,516.8 |
| VERIFICATION & CONTROL TECHNOLOGY | 51.5 | 52.0 | 53.9 | 53.9 |
| MATERIALS PRODUCTION | 1,157.8 | 940.9 | 1,188.1 | 1,228.5 |
| DEFENSE NUCLEAR WASTE | 414.8 | 367.4 | 501.0 | 520.8 |
| NUC. MATERIALS SECURITY & SAFEGUARDS | 45.5 | 45.5 | 47.4 | 47.4 |
| SECURITY INVESTIGATIONS | 23.6 | 23.6 | 28.5 | 28.5 |
| TOTAL DEFENSE PROGRAMS | $4,793.7 | $4,411.4 | $5,257.5 | $5,395.9 |
| NAVAL REACTORS | 326.5 | 359.1 | 385.8 | 420.8 |
| TOTAL ATOMIC ENERGY DEFENSE ACTIVITIES | $5,120.2* | $4,770.5* | $5,643.3 | $5,816.7 |

*EXCLUDES BUDGET COMPARABILITIES OF $18.1M

CHART 3

The Agency's FY 1983 amended budget request for Atomic Energy Defense Activities totals about $5.8 billion, in new Budget Authority, as indicated on this chart. Of this amount, $5.4 billion is for Defense Programs with the remainder for the Naval Reactors Program. To support this, we are requesting new authorization of nearly $5.3 billion. The Defense Programs supplemental request for FY 1982 is $97.4 million, raising the total FY 1982 to about $4.4 billion. The requested increase for Defense Programs in FY 1983 over FY 1982 is about $1.0 billion, or approximately 23 percent.

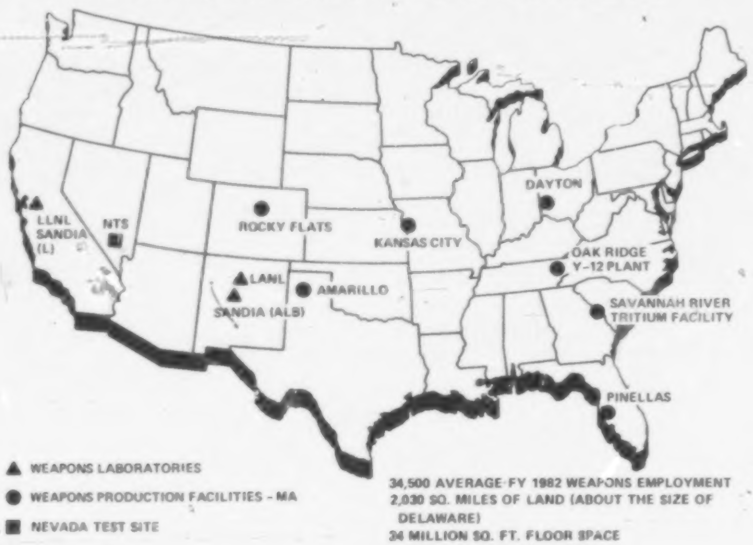
In the context of our responsibilities, this is an austere budget, reflective of the need for restraint in Federal spending. But at the same time, it does provide the resources we need to meet the FY 1983 Nuclear Weapons Stockpile Memorandum. Further, it provides for continuing initiatives to assure the vitality, develop the stability, and restore the capability of the Defense Programs Complex necessary to enable us to meet our nuclear defense requirements in the future.

First, I would like to discuss our plans for FY 1983 in the nuclear weapons program.

I would like to begin by describing the weapons complex for you.

## DEFENSE PROGRAMS — WEAPONS ACTIVITIES

WEAPONS DEVELOPMENT, TESTING, AND PRODUCTION FACILITIES



34,500 AVERAGE FY 1982 WEAPONS EMPLOYMENT
2,030 SQ. MILES OF LAND (ABOUT THE SIZE OF DELAWARE)
34 MILLION SQ. FT. FLOOR SPACE
250,000 ITEMS OF EQUIPMENT
$11 BILLION ESCALATED ACQUISITION COSTS IN FY 1983 DOLLARS

**CHART 4**

Here are the locations of our major weapons program facilities. The nuclear weapons complex includes three design laboratories, the Nevada Test Site (NTS), and seven production facilities. Of the three laboratories, the Los Alamos National Laboratory (LANL) and the Lawrence Livermore National Laboratory (LLNL) are responsible for nuclear design, while the Sandia National Laboratories (SNL) are responsible for ordnance engineering. All three are broad-based, multiprogram laboratories skilled in the physical sciences and engineering. The NTS is the only location where underground nuclear tests currently are conducted by the United States. The seven production facilities are spread throughout the U.S. and operate as an integrated industry with each facility responsible for production of specific weapon parts or components. Final assembly of nuclear weapons is performed at the Pantex plant near Amarillo, Texas. Perspective of the national scope and size of the nuclear weapons complex can be gained from the following:

Major facilities are located in ten states;
Facilities occupy a total land area about the size of Delaware;
The average FY 1982 contractor employment will be about 34,500.

[Chart 5 deleted.]

As this Chart shows, from the air our production plants look like a cross-section of American industry. Once on the inside one begins to see the extent and diversity of their capabilities.

[Chart 6 deleted.]

From the equipment for the machining of large castings shown in this picture [Chart 7 deleted] to the assembly and inspection of small, complex components we operate at the forefront of high technology and precision in many of our operations.

[Chart 8 deleted.]
[Chart 9 deleted.]

The research and development facilities are diverse and capable, dealing as they must with all aspects of the physical world, from the extreme temperatures and accelerations many weapons must withstand to the special environments peculiar to nuclear weapons.

[Chart 10 deleted.]

Here you see part of the computer complex at the Lawrence Livermore National Laboratory. Our laboratory computational capabilities represent a unique national asset.

[Chart 11 deleted.]

This is the Particle Beam Fusion Accelerator at Sandia, useful is examining the physics of the nuclear weapons, as well as in studying the concepts and theories of inertial fusion.

[Chart 12 deleted.]

This is a high explosive experiment at the Los Alamos PHERMEX facility in preparation for an underground nuclear test at the Nevada Test Site.

[Chart 13 deleted.]

Testing involves a wide variety of activities but the centerpiece is the full-scale nuclear testing operation in Nevada about one hundred miles northwest of Las Vegas.

[Chart 14 deleted.]

These cables go down hole to the test device and route diagnostic signals to a vast array of equipment contained in these trailers. Tests today are more complex and costly than their predecessors—but they return more data and hence more knowledge.

[Chart 15 deleted.]

The actual test device is contained in the large canister you see being lowered down hole. In many ways the testing operation resembles the heavy construction industry as much as a high technology data acquisition effort.

## WEAPON PRODUCTION PROGRAMS

### CHART 16

### WEAPON PROGRAM PRODUCTS

Strategic systems.
Long range theater nuclear systems.
Battlefield nuclear systems.
Fleet air defense.

The people and equipment which are the primary assets of our endeavor have produced and are continuing to produce a line of products that is second to none. Some twelve systems will be in production or development through FY 1983 in four different mission categories.

## STRATEGIC WEAPONS

[Chart 17 deleted.]

First, I'll discuss the strategic systems.

The W76 warhead for the TRIDENT missile is in production [deleted].

The W78 is an improved warhead for the MINUTEMAN III ICBM system. [Deleted.]

We now have a Phase 3 request for an MX warhead. [Deleted.]

The B83, [deleted] is a modern high-yield bomb.

[Deleted.]

## LONG-RANGE THEATER NUCLEAR SYSTEMS

[Chart 18 deleted.]

Turning now to the long-range theater nuclear systems, we have one bomb and two warhead programs underway.

The W84 warhead is in production engineering for the ground launched cruise missile. [Deleted.]

The W85 is in production engineering as a warhead for the PERSHING II Ballistic Missile system. [Deleted.]

The B61 is a modern tactical bomb currently being produced in two versions [deleted].

### BATTLEFIELD NUCLEAR SYSTEMS

[Chart 19 deleted.]

There is also an ongoing effort to upgrade the shorter range tactical systems. An improved LANCE warhead and one new artillery shell is currently in production with a second artillery shell being developed.

The W70 is a modernized warhead for the LANCE missile. It is one of the warheads with the reduced blast/enhanced radiation feature. [Deleted.]

The W79, which was first delivered in FY 1981, is a replacement warhead for the existing W33 8-inch artillery fired atomic projectile. [Deleted.]

The W82 is in development engineering as a replacement for the W48 155mm artillery fired atomic projectile. [Deleted.]

### FLEET AIR DEFENSE

[Chart 20 deleted.]

There is one Fleet Air Defense warhead in development. The W81 provides a nuclear warhead for the Navy's SM-2 missile for defense against nuclear-armed air, surface, and submarine launched cruise missile threats. [Deleted.]

### WEAPONS RESEARCH EFFORTS

Now let me turn to the research, development and testing work, the foundation for our future weapon systems.

[Deleted.]

### INERTIAL CONFINEMENT FUSION

## DEFENSE PROGRAMS -- WEAPONS ACTIVITIES

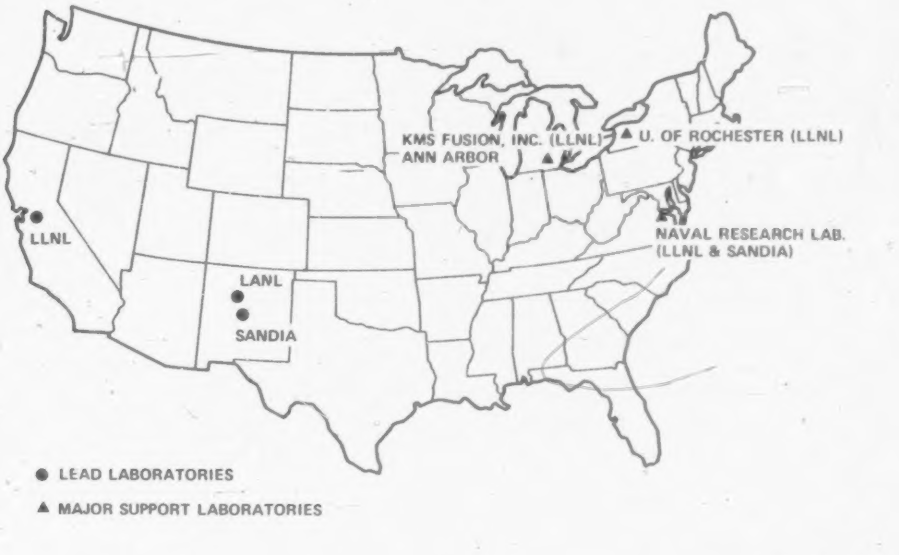


CHART 23

We have structured the Inertial Confinement Fusion program so that the three lead laboratories have technical responsibility for the three main driver approaches and for insuring that inertial confinement fusion activities support the overall nuclear weapons research, development, and testing effort.

[Chart 24 deleted.]

# INERTIAL FUSION CONCEPT

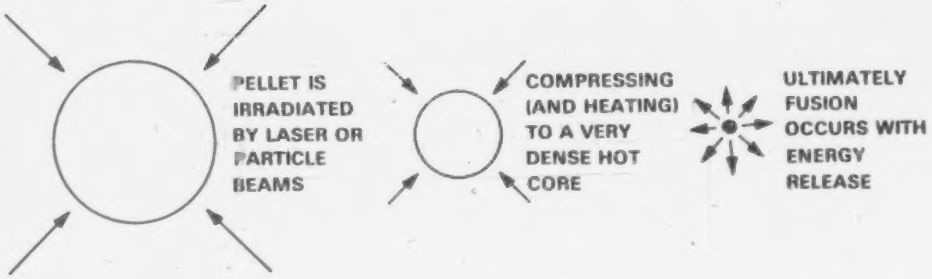

PELLET IS IRRADIATED BY LASER OR PARTICLE BEAMS
COMPRESSING (AND HEATING) TO A VERY DENSE HOT CORE
ULTIMATELY FUSION OCCURS WITH ENERGY RELEASE

CHART 25

The concept is that the laser or particle beam will deliver sufficient energy on the target to cause fusion and consequent energy release.

Our current task in Inertial Confinement Fusion is to work toward pellet ignition and significant thermonuclear burn in optimized targets using the large laser and particle beam machines now being built. The Antares $CO_2$ laser facility at LANL will be completed and operating by fiscal year 1984. The PBFA II accelerator at Sandia, Albuquerque will be completed in fiscal year 1986, as will the NOVA glass laser at the Livermore Laboratory in fiscal year 1985.

[Charts 26–29 deleted.]

[Deleted.]

[Chart 30 deleted.]

The key to productivity gains is the aggressive pursuit of high leverage innovations such as computer-assisted design and manufacturing (CAD/CAM). With CAD, design changes can be developed and analyzed in much less time. Coupled with an interactive graphics system (IGS), CAD permits dissemination of design changes throughout the entire complex on a time-scale unapproachable with current methods. The explosive development of electronics has resulted in new horizons in CAM as well. Digital, numerically controlled machines offer extreme flexibility and quality in production operations. The incorporation of robotics in industrial practice is featured in high-productivity nations, such as Japan, and is being initiated in the U.S.

Investment in innovations such as CAD/CAM and robotics today will result in significant productivity gains and cost benefits in the future. It will also provide major gains in the repeatability of highly complex part production to the extreme tolerances required of modern nuclear weapons.

We are planning balanced and appropriate initiatives to pursue these efforts to maximum advantage as they become realizable. Specifically, I call your attention to a $12 million line item in construction for an Interactive Graphics System which will support a significant first step in implementing an integrated CAD/CAM system. This project was authorized at a level of $9.0 million in FY 1982; but, thus far, no funds have been appropriated.

[Deleted.]

In FY 1982 funding increases for capital equipment exceeded the inflation rate. We have been receiving support for the restoration program for the past few years. Progress is being made and even though the restoration program has slipped from six years to seven, we are beginning to see results.

[Chart 31 deleted.]

This Chart shows a conventional manually-operated lathe. The Kansas City Plant has approximately 25 of these machines for production of weapon components.

[Chart 32 deleted.]

Here you see a replacement lathe which is computer controlled. This new machine has been responsible for a 30 percent reduction in machining time.

[Chart 33 deleted.]

The first replacement lathe was installed in March 1981 with 10 more being delivered through November.

The dramatic reductions in total machine requirements will permit procurement of fewer machines over the next 2–3 years to meet the projected workload.

The economic payback period on the new machines is expected to be less than 2½ years, based on a ten-shift-per-week operation.

[Chart 34 deleted.]

In the next example three older mills with very limited capabilities could not carry out the currently projected workload. The machines had become worn and would no longer produce to design tolerances reliably.

[Chart 35 deleted.]

This new four-axis mill has replaced the three mills just shown.

[Chart 36 deleted.]

Tolerance capabilities have been regained with acquisition of the new equipment and productivity gains are being experienced.

While these are just two examples, and much other progress has been made, I do not want to give you the impression that things are "just fine" and we can relax. There is still much to be done to provide for future needs.

[Charts 37 and 38 deleted.]

FISCAL YEAR 1983 BUDGET REQUEST

## DEFENSE PROGRAMS — WEAPONS ACTIVITIES

### FY 1983 WEAPONS ACTIVITIES BUDGET REQUEST
(BA $ MILLIONS)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| | AUTHORIZATION AS ENACTED | APPROPRIATION INCL. SUPPLEMENTAL | AUTHORIZATION AS AMENDED | APPROPRIATION AS AMENDED |
| OPERATING | | | | |
| PRODUCTION AND SURVEILLANCE | $1,351.8 | $1,284.6 | $1,573.8 | $1,573.8 |
| RESEARCH, DEVELOPMENT, AND TESTING | 959.1 | 949.3 | 1,075.0 | 1,075.0 |
| INERTIAL CONFINEMENT FUSION | 141.0 | 122.4 | 122.0 | 122.0 |
| PROGRAM DIRECTION | 42.7 | 50.2 | 51.3 | 51.3 |
| TOTAL OPERATING | 2,494.6 | 2,406.5 | 2,822.1 | 2,822.1 |
| CONSTRUCTION | 409.4 | 424.3 | 415.5 | 493.8 |
| EQUIPMENT | 196.5 | 163.1 | 201.0 | 201.0 |
| TOTAL WEAPONS ACTIVITIES | $3,100.5 | $2,993.9 | $3,438.6 | $3,516.9 |

CHART 39

This Chart gives an overall view of the amended FY 1983 request for weapons activities which total approximately $3.5 billion in budget authority. We also need about $3.4 billion in new authorization. About $153 million of budget authority and $133 million new authorization is devoted to the inertial confinement fusion program. Note that in all other areas requested increases provide for program growth in keeping with our need to address the issues I have just discussed.

REQUEST FOR OPERATING FUNDS

## DEFENSE PROGRAMS – WEAPONS ACTIVITIES

### FY 1983 WEAPONS BUDGET PRODUCTION AND SURVEILLANCE OPERATING EXPENSES (B/A $ Millions)

| | FY 1982 | | FY 1983 REQUEST | |
|---|---|---|---|---|
| | AUTHORIZATION AS ENACTED | APPROPRIATION INCL. SUPPLEMENTAL | AUTHORIZATION AS AMENDED | APPROPRIATION AS AMENDED |
| WAR RESERVE NEW PRODUCTION | $ 863.7 | $ 829.7 | $ 977.2 | $ 977.2 |
| STOCKPILE MAINTENANCE | 98.6 | 97.5 | 139.0 | 139.0 |
| STOCKPILE EVALUATION | 119.8 | 116.2 | 144.5 | 144.5 |
| PROCESS DEVELOPMENT | 72.3 | 70.5 | 86.2 | 86.2 |
| OTHER COSTS | 197.4 | 170.7 | 226.9 | 226.9 |
| TOTAL OPERATING EXPENSES | $1,351.8 | $1,284.6 | $1,573.8 | $1,573.9 |

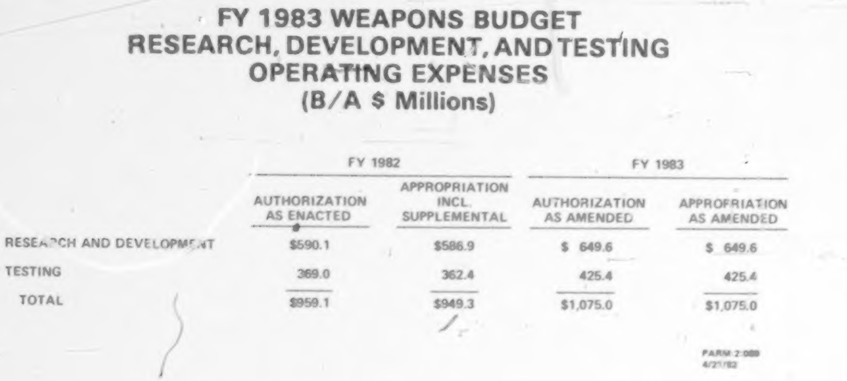
CHART 40

The production and surveillance operating budget of about $1.6 billion includes funds requested for our seven plants that manufacture components and assemble nuclear weapons.

The funds provide for production of new war reserve weapons; lifetime surveillance and maintenance of the weapons stockpile; process development to prepare for new designs and improve technology; the retirement of warheads, and a stockpile improvement program to modernize certain older weapons currently in the United States nuclear stockpile.

With regard to the research, development and testing program, the FY 1983 request for operating funds is just under $1.1 billion, $649.6 million for research and development and $425.4 million for testing. The FY 1982 Supplemental request is $15.0 million, necessary to maintain employment levels at the laboratories and the test site. These funding levels support last year's decision to return to a more vigorous testing program and provide the associated research and development.

## DEFENSE PROGRAMS — WEAPONS ACTIVITIES



FY 1983 WEAPONS BUDGET
RESEARCH, DEVELOPMENT, AND TESTING
OPERATING EXPENSES
(B/A $ Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| | AUTHORIZATION AS ENACTED | APPROPRIATION INCL. SUPPLEMENTAL | AUTHORIZATION AS AMENDED | APPROPRIATION AS AMENDED |
| RESEARCH AND DEVELOPMENT | $590.1 | $586.9 | $ 649.6 | $ 649.6 |
| TESTING | 369.0 | 362.4 | 425.4 | 425.4 |
| TOTAL | $959.1 | $949.3 | $1,075.0 | $1,075.0 |

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4/21/82

CHART 41

### Chart 42

FISCAL YEAR 1983 WEAPONS BUDGET, INERTIAL FUSION OPERATING EXPENSES
(BUDGET AUTHORITY)

Fiscal year 1982, $122.4 million.
Fiscal year 1983 amended request, $122 million.

The requested inertial fusion operating funds for FY 1983 amount to $122 million.

Funding for Program Direction is the final element in our operating request. The amount of $51.3 million is reqeusted in FY 1983, for salary, benefits and travel expense of the 927 Federal employees associated with the technical direction and management of the weapons program. Approximately $10 million is for the Community Assistance Program at Los Alamos and Oak Ridge. Also included is the fu[illegible]or the contractual services and supplies necessary to support the Albuq[illegible]d Nevada Operations Offices.

### [illegible]L EQUIPMENT BUDGET REQUEST

### Chart 43

WEAPONS ACTIVITIES, FISCAL YEAR 1983 BUDGET REQUEST, CAPITAL EQUIPMENT
(BUDGET AUTHORITY)

Fiscal year 1982, $163.1 million.
Fiscal year 1983, $201 million.

Our total capital equipment request, including computers and Inertial Fusion, comes to $201 million. Included in this request is $19.5 million for the purchase of laboratory and production complex computer equipment.

## CONSTRUCTION BUDGET REQUEST

## DEFENSE PROGRAMS — WEAPONS ACTIVITIES

### CONSTRUCTION PROJECTS
(Dollars in Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| | AUTHORIZATION AS ENACTED | APPROPRIATION INCL. SUPPLEMENTAL | AUTHORIZATION AS AMENDED | APPROPRIATION AS AMENDED |
| PRODUCTION & SURVEILLANCE | | | | |
| CONTINUING PROJECTS | $138.5 | $178.4 | $354.1 | $412.6 |
| NEW PROJECTS | 214.8 | 149.3 | 39.6 | 39.6 |
| FY 1982 GENERAL REDUCTION | – | -51.0 | – | – |
| SUBTOTAL | $353.3 | $276.7 | $393.7 | $452.2 |
| RESEARCH, DEVELOPMENT, & TESTING | | | | |
| CONTINUING PROJECTS | 3.0 | 39.8 | 6.0 | 6.0 |
| NEW PROJECTS | 53.1 | 32.1 | 15.8 | 15.8 |
| SUBTOTAL | $ 56.1 | $ 71.9 | $ 21.8 | $ 21.8 |
| INERTIAL FUSION | | | | |
| CONTINUING PROJECTS | – | 75.7 | – | 19.8 |
| NEW PROJECTS | – | – | – | – |
| SUBTOTAL | $ – | $ 75.7 | $ – | $ 19.8 |
| TOTAL | $409.4 | $424.3 | $415.5 | $493.8 |

CHART 44

Our total construction program, including Inertial Fusion, comes to almost $494 million in appropriation and $415.5 million in new authorization. Included in this request is funding for general plant projects and two new weapons system projects as well as funding for fourteen prior year construction projects. The amended construction request for Inertial Fusion is $19.8 million for continuation of the 10 beam NOVA project and the Particle Beam Fusion Accelerator II.

## VERIFICATION AND CONTROL TECHNOLOGY

Now, Mr. Chairman, I would like to discuss our Verification and Control Technology Program.

CHART 45

### GOALS

Develop and produce nuclear test treaty verification and monitoring technology.

Execute export control, technology transfer responsibilities.

Support technical and analytical aspects of arms control policy and implementation.

Provide agency expertise and support to the national foreign intelligence program.

This program has four specific goals:

To provide the technology and equipment necessary to monitor foreign nuclear explosions conducted underground, in the atmosphere and in space, and to monitor compliance with nuclear weapons-related treaties.

To control proposed exports of nuclear and energy-related materials, equipment and technology to insure they are consistent with U.S. national security and with nonproliferation policy.

To provide technical and analytical support for the Agency's role in nuclear arms control negotiations, policy formulation and implementation.

To provide Defense Programs' unique weapons and nuclear-related expertise to the Intelligence Community.

Activities within the Verification and Control Technology program fall into two functional categories—detection technology and analytical support, both of which draw upon the unique expertise, skills and resources of the national nuclear weapons laboratories.

## DETECTION TECHNOLOGY

The detection technology component of the program encompasses a wide range of technologies—spaceborne sensors, seismic, nonseismic, debris detection and sample analysis, and on-site monitoring.

### SPACEBORNE SENSORS

### CHART 46

### SPACEBORNE SENSORS—FISCAL YEAR 1983 EFFORT

[Deleted.]
Sensors for global positioning satellite (GPS).
Engineering for Shuttle-compatible satellites.
Continue deep space technology development.
Maintain R&D base.
Continue operational support for delivered systems.

The overall purpose of our space effort is to develop and maintain U.S. capability to detect and characterize nuclear explosions from spaceborne platforms. The effort includes research and development, the actual fabrication of sensor packages, and operational support, which provides for integration of sensor subsystems with launch platforms, for calibration and testing of subsystems, and evaluation and analysis of data collection, processing and exploitation.

### SEISMIC DETECTION

### CHART 47

### SEISMIC DETECTION

Determine effectiveness of regional seismic detection.
Continue R&D technology for seismic detection.
Operate regional seismic test network (RSTN).

The aim of the seismic detection program is to determine the effectiveness of regional—that is, short-range—seismic signals for monitoring compliance with nuclear test ban treaties. Such regional seismic monitoring would augment teleseismic—that is, long-range—monitoring as a verification tool. [Deleted.]

In FY 1982 we are completing establishment of a Regional Seismic Test Network as a model to learn how an in-country system might function. The regional network is composed of five seismic stations—three in the United States and two in Canada—linked via satellite to a control point in Albuquerque, New Mexico. During FY 1983, which will be its first full year of operation, the Regional Seismic Test Network will gather seismic data which will be analyzed to determine our capabilities to discriminate between seismic signals generated by earthquakes and those generated by explosions.

### NONSEISMIC DETECTION

### CHART 48

### NONSEISMIC DETECTION

R&D on use of atmospheric phenomena for underground nuclear explosion detection.
Infrasonic monitoring.
Ionospheric monitoring.

The nonseismic detection program is a research and development effort aimed at determining whether certain atmospheric phenomena can be reliable indicators of under ground nuclear explosions. The nonseismic program has two main components—infrasonic monitoring and ionospheric monitoring. In infrasonic monitoring we try to detect and measure very low frequency sound waves to determine if it is possible to detect underground explosions acoustically. In ionospheric monitoring we try to detect and measure perturbations of the upper atmosphere caused by underground explosions. Fiscal year 1983 efforts will continue a long-term earthquake monitoring effort to determine the potential for distinguishing between ionospheric phenomena generated by "false alarms" such as earthquakes and those generated by underground explosions.

### DEBRIS DETECTION AND SAMPLE ANALYSIS

[Chart 49 deleted.]
[Deleted.]

### ON SITE MONITORING

### CHART 50

### OTHER ACTIVITIES

PNET onsite verification readiness.
Analytical support:
Export control/technology transfer.
Arms control/negotiations support/policy studies.
Weapons and proliferation intelligence.
[Deleted.]

The Peaceful Nuclear Explosions Treaty, which along with the Threshold Test Ban Treaty awaits Senate advice and consent to ratification, provides for the United States and the Soviet Union to conduct observations and examinations on each other's territories for certain peaceful nuclear explosions, minimizing any military benefits otherwise banned. This on-site monitoring provision is important in arms control agreements with the Soviet Union, and the United States hopes that someday the on-site principle will be widely applied.

The Vertification and Control Technology program has developed the necessary equipment and has resignated Defense Programs personnel with the necessary skills, to fulfill our responsibilities.

### ANALYTICAL SUPPORT

Analytical support activities fulfill our responsibilities in export control, technology transfer, international scientific exchange, arms control, weapons intelligence and proliferation intelligence. These activities marshall the expertise, data and analysis to take part in negotiating and implementing arms control and other agreements, to meet national needs in understanding foreign nuclear weapons programs and nuclear proliferation, and to control the export of weapons-related materials and equipment and the transfer of related technology.

In the export control area, it is our responsibility to review proposed nuclear and energy-related exports and technology transfers, and international cooperation and exchange agreements. This enables senior management to meet its statutory responsibility of assuring that these activities are consistent with U.S. national security and nonproliferation policy.

Because of the unique experience and resources of the U.S. nuclear weapons complex, we also are called upon to support the Department of Defense in identifying militarily critical technologies and to support the Departments of State and Commerce in carrying out their important responsibilities for controlling U.S. exports and international cooperation and exchanges.

We have been and will continue to be deeply involved in the implementation of a Presidential directive to seek agreement with other nuclear supplier countries on the conditions that should be applied to sensitive nuclear exports.

Defense Programs' responsibility for the U.S. nuclear weapons program makes essential its participation in the arms control process. Verification and Control Technology has responsibility for Defense Programs in the arms control arena, participating in the U.N. Committee on Disarmament and bilateral and trilateral negotiations on possible nuclear test limitation agreements, participating in the interagency backstopping committees supporting negotiations, and arranging for weapons laboratories scientists to provide technical representation. We also participate in the interagency working group that prepares annual Arms Control Impact Statements on nuclear weapon activities.

In our weapons intelligence activity, the Intelligence Community traditionally has turned to the nuclear weapons laboratories for expertise in analyzing information on foreign nuclear weapons, especially Soviet weapons. The fundamental purpose is to provide a sound technical basis for the Intelligence Community's assessment of the Soviet threat. An additional purpose is to assess consequences of nuclear test limitations and their possible asymmetrical impact on U.S. and Soviet nuclear weapons programs. [Deleted.]

In response to the Atomic Energy Act, the Nuclear Non-Proliferations Act, and other laws and to Presidential and Director of Central Intelligence directives, we assist the Intelligence Community in analyzing collected information and produce assessments of the nuclear activities, technical capabilities and motives of possible proliferant countries. [Deleted.]

BUDGET REQUEST

## VERIFICATION AND CONTROL TECHNOLOGY

### FUNDING REQUEST

(B/A IN $ MILLIONS)

| | FY 1982 | | |
|---|---|---|---|
| | AUTHORIZATION AS ENACTED | APPROPRIATION INCL. SUPPLEMENTAL | FY 1983 |
| OPERATING EXPENSES | $ 48.6 | $ 49.1 | $ 50.6 |
| DETECTION TECHNOLOGY | (38.2) | (38.7) | (41.7) |
| ANALYTICAL SUPPORT | (10.4) | (10.4) | ( 8.9) |
| PROGRAM DIRECTION | 1.8 | 1.8 | 1.8 |
| CAPITAL EQUIPMENT | 1.1 | 1.1 | 1.5 |
| TOTAL | $ 51.5 | $ 52.0 | $ 53.9 |

DELETED

CHART 51

The Verification and Control Technology request for FY 1983 is $52.4 million for operating expenses and $1.5 million for capital equipment. Our FY 1982 supplemental request of $2.0 mililon is needed to maintain the schedule for delivery of a new spaceborne detection instrument package. The increase of $1.9 million over FY 1982 is mainly associated with the requirements for spaceborne nuclear explosion detection systems. [Deleted.]

Capital equipment expenditures support research, development, test and production activities through the provision of test equipment and instrumentation related to the total program. There is a continuing need to update test equipment at the Sandia National Laboratories, the Lawrence Livermore National Laboratory and the Los Alamos National Laboratory. Most equipment is small scale bench test equipment such as oscilloscopes, electronic calibration devices and small scale electronic support devices.

Program direction funds provide for the salaries, benefits, and travel expenses for 37 FTE's associated with the management and direction of this program at the Headquarters facility located in Washington, D.C. The requested funding of $1.8 million provides for full year staff support, employees advancement and normal administrative cost. These employees are responsible for technical and analytical program management of field activities, and execution of Headquarters staff functions.

### SAFEGUARDS AND SECURITY

### CHART 52

### MISSION

Protect classified information against misuse; protect nuclear weapons, materials and facilities against theft and sabotage; and provide safeguards technical support to U.S. and international activities to minimize the proliferation of nuclear weapons.

Now, I will turn to the Nuclear Materials Security and Safeguards program. The primary mission of the Agency's activities in this area is the protection of classified information and nuclear weapons, materials and facilities against theft and sabotage. This mission is accomplished through development and implementation of policies and procedures, as well as development and application of components and systems, for assuring such protection. The program also focuses on providing safeguards technical support to United States and international activities to minimize the proliferation of nuclear weapons.

The Nuclear Materials Security and Safeguards program encompasses both operational and developmental activities. The former includes such safeguards and security operations as the Nuclear Materials Management and Safeguards System, which is our master U.S. nuclear material tracking information system; the New Brunswick Laboratory; and the validation of guard training requirements. Developmental activities in enhancing safeguards and security are carried out largely by the national laboratories and the resulting improvements are then transferred to Agency operations. I should point out that this program does not fund the actual plant, capital equipment, and operating expenses of Agency-wide safeguards and security systems at Agency facilities.

### NUCLEAR MATERIALS SECURITY AND SAFEGUARDS

### CHART 53

### MAJOR ACTIVITIES

**Security operations.**
**Safeguard operations.**
**International safeguards.**
**Technology development.**
**Classification.**
**Program direction.**

The Nuclear Materials Security and Safeguards program consists of six basic elements. These are: security operations, safeguards operations, international safeguards, technology development, classification, and program direction.

### SECURITY OPERATIONS

The Security Operations element of our program provides guidance and direction for the Agency's capabilities to protect classified information and material. Present activities include emphasis in the areas of understanding the potential threats, vulnerabilities and related consequences to our resources and ensuring protective force readiness to deal with adversary challenges. Through the Security Operations program, valuable counter-intelligence information related to the foreign intelligence threat is analyzed and disseminated to appropriate Agency components. Additional efforts emphasize computer security and technical security activities.

New standards and related training programs are being established for the Agency's protective forces. The Multiple Integrated Laser Engagement Systems (MILES), which uses weapons modified to shoot harmless laser beams instead of ammunition, is being used extensively in the guard force tactical training program.

### SAFEGUARD OPERATIONS

I will now turn to Safeguards Operations which involves three major functions: technical safeguards assistance to Agency field operations, the nuclear material control and accountability program which includes the Nuclear Materials Management and Safeguards System, and operation of the New Brunswick Laboratory at Argonne, Illinois.

A high priority effort in our program is providing expert technical assistance to Agency facility managers. This assistance supports application of the latest state-of-the-art safeguards and security equipment and integrated systems. Areas for improvement have been identified through on-site inspections, vulnerability assessments, and field office requests. Site-specific assistance for identified improvements to weapons and nuclear materials production program facilities is planned for a number of sites.

The Nuclear Materials Management and Safeguards System is the sole national nuclear materials computerized data base for tracking the status and location of nuclear materials in the U.S. It serves the Nuclear Regulatory Commission (NRC) as well as this Agency. The system receives and processes information on 18 types of nuclear materials owned and used by this and other government agencies, as well as nuclear materials leased to or owned by private companies in the U.S.

Heightened concern over the "insider threat" has sparked the need for reexamination of the role of material control and accountability to ensure timely detection of material diversion. Material control and accountability activities planned or in progress include the development of standard statistical techniques to evaluate inventory differences at Agency facilities.

This program supports the New Brunswick Laboratory which serves the Agency's nuclear contractors, NRC licensed facilities and the international community. This is the principal U.S. laboratory for nuclear material measurements and standards and inventory verification of safeguards inspectors' samples.

I mentioned in my preliminary remarks the Agency-wide budget for safeguards and security. Our function in that specific area is to work closely with the field and program offices in identifying and analyzing deficiencies in safeguards and security systems, and in coordinating followup actions to assure that proper remedial actions are taken in response to these identified deficiences.

## INTERNATIONAL SAFEGUARDS

In the area of International Safeguards, the primary objective is to support U.S. nonproliferation and national security objectives. This program is directly responsible for the development of international safeguards systems required for facilities in the United States that may become eligible for International Atomic Energy Agency (IAEA) safeguards inspection under the recently enacted treaty between the United States and the IAEA, the so-called "Volunteer Offer".

Another major effort concerns direct support to the International Atomic Energy Agency. The program includes management of a U.S.-funded Program of Technical Assistance to the IAEA in response to urgent requirements identified by the IAEA. Also, much of the technology which we develop for domestic application is transferred selectively to the IAEA to assist it in meeting its objectives of effectively safeguarding nuclear materials and facilities world-wide.

## TECHNOLOGY DEVELOPMENT

Research and development is conducted on a range of components and systems for physical protection and material control and accountability. Efforts focus on developing components to solve identified deficiencies and provide performance specifications for equipment to be used at existing Agency facilities or new facilities in the design stage.

In the past several years, funding emphasis has been shifted from technology development to current operational problems. Equipment to identify and allow access of only authorized personnel, as well as to prevent entry of contraband, will be evaluated in operational environments at one or more Agency facilities. A broadened base of capability for measuring uranium and plutonium materials will be pursued to reflect the increasing need and benefits of automated, remote measurements in safeguarding materials.

## CLASSIFICATION

The Agency's classification function is under my direction. Formerly, this activity was funded under the Agency's Departmental Administration Appropriation. This year, for the first time, funds are being requested for this work as part of the Atomic Energy Defense Activities Appropriation, in the Nuclear Materials Security and Safeguards program.

The objectives of the program are to establish and implement policy for the classification of Restricted Data, Formerly Restricted Data, and National Security Information within the Agency's jurisdiction in accordance with the requirements of the Atomic Energy Act of 1954, as amended, and applicable Executive Orders. The program must also assure the continuous review of Restricted Data in order to determine what may be declassified and disseminated in the interest of scientific and technical progress and the general welfare, without damage to the national security.

Specifically, the Classification program (1) provides continuing guidance to Headquarters and field organizations on classification and declassification policies and procedures; (2) develops and updates classification guidance for nuclear weapons and other classified area; (3) handles classification and declassification reviews, such as Freedom of Information Act requests, and Mandatory Review Requests pursuant to applicable Executive Orders; and (4) performs appraisals of field office and contractor classification functions.

In compliance with Congressional, General Accounting Office and Inspector General commitments, a comprehensive Classification Review Program rereview project will continue in fiscal year 1983.

## PROGRAM DIRECTION

Our FY 1983 budget request includes program administration supporting a total of 139 positions, including 33 for the classification program. It should be observed that many of the functions necessary for the successful fulfillment of these responsibilities are headquarters/personnel intensive. For example, a substantial portion of this program's staff is involved in providing security support and in the processing and analysis of over 25,000 security investigations per year.

## PLANT AND CAPITAL EQUIPMENT

Our budget request for Nuclear Materials Security and Safeguards contains a modest amount for capital equipment required to support the safeguards and security program I have described. It also includes a general plant project at the New Brunswick Laboratory for the plutonium handling operation that requires alterations for health and safety improvements including modification and upgrade of the exhaust scrubber system and modification and replacement of deteriorating ventilation duct work.

## SECURITY INVESTIGATIONS

### CHART 54

Security investigation/clearance process is key element in security system.
Investigations conducted by OPM and FBI.
Approximately 29,000 clearances to be conducted in FY 83.
Adequate funding is required to ensure cleared personnel are available for defense programs.

I will now address the Security Investigations Program. The amended FY 1983 budget request for Security Investigations is $28.5 million. These funds are used to reimburse the Federal Bureau of Investigation (FBI) and the Office of Personnel Management (OPM) for conducting background investigations on Agency employees, contractor employees, and consultants prior to their being granted access to classified information, classified materials, or special nuclear materials. The background investigation is required by the Atomic Energy Act of 1954, as amended, and by Executive Order 10450 to insure that access to classified information, classified material, or special nuclear material will not endanger the national security.

The FY 1983 amended budget provides for approximately 18,200 background investigations and 10,800 national agency checks. The majority of background investigations support defense activities but are also required for personnel in the uranium enrichment program, and nuclear energy research and development programs.

Although costs for the investigations have risen substantially over the past few years, we have completed a high percentage of the clearances required by the Agency programs.

BUDGET REQUEST

## DEFENSE PROGRAMS – NUCLEAR MATERIALS SECURITY AND SAFEGUARDS

### FY 1983 AUTHORIZATION REQUEST
($ Millions)

### NUCLEAR MATERIALS SECURITY AND SAFEGUARDS

| | ENACTED FY 1982 | FY 1983 AMENDED REQUEST |
|---|---|---|
| OPERATING EXPENSES | | |
| OPERATIONS | $37.8 | $37.3 |
| PROGRAM DIRECTION | 4.0 | 5.9 |
| TOTAL OPERATING EXPENSES | $41.8 | $43.2 |
| CONSTRUCTION | 0 | 0.5 |
| EQUIPMENT | 3.7 | 3.7 |
| TOTAL | $45.5* | $47.4 |

### SECURITY INVESTIGATIONS

| | ENACTED FY 1982 | FY 1983 AMENDED REQUEST |
|---|---|---|
| OPERATING EXPENSES | $23.6 | $28.5 |
| TOTAL | $23.6 | $28.5 |

*EXCLUDES PLUS $1.7 MILLION COMPARABILITY ADJUSTMENTS.

CHART 55

In summary, Mr. Chairman, we are requesting authorization of $47.4 million for the Nuclear Materials Security and Safeguards Program and $28.5 million for the Security Investigation Program. As I mentioned earlier, I believe we are on the proper course and, with your continued support, we will continue to improve our effectiveness.

Now, Mr. Chairman, I will turn to the Nuclear Materials Production Program.

### NUCLEAR MATERIALS PRODUCTION

CHART 56

MISSION

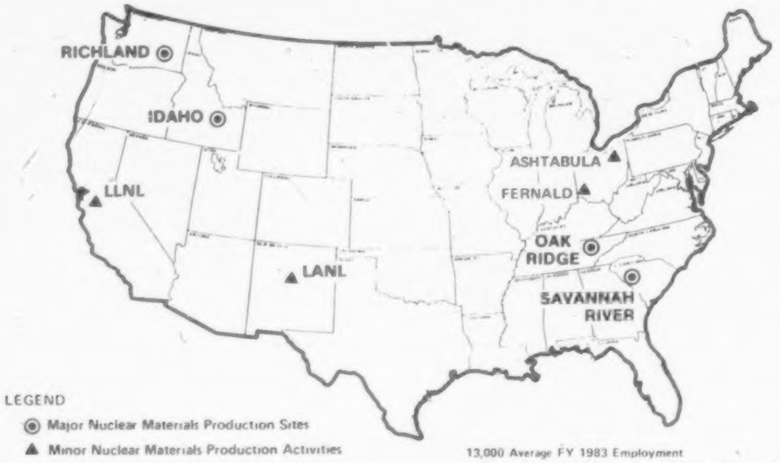
Production of nuclear materials: plutonium; tritium; other radioisotopes.

For use in: military programs; Government research and development—e.g., breeder reactors; industry, medicine, commerce.

The Materials Production program is responsible for the production of nuclear materials primarily for use in military programs, but also for use in government research and development programs such as the breeder reactor, and civilian programs which use radioisotopes in medical, research and commercial applications. Almost all of these materials are produced in nuclear reactors dedicated to this production effort.

## DEPARTMENT OF ENERGY

### NUCLEAR MATERIALS PRODUCTION SITES


RICHLAND
IDAHO
LLNL
LANL
ASHTABULA
FERNALD
OAK RIDGE
SAVANNAH RIVER
LEGEND
◉ Major Nuclear Materials Production Sites
▲ Minor Nuclear Materials Production Activities

13,000 Average FY 1983 Employment
1853 Sq. Miles of Land—1½ Times the Size of Rhode Island
$12.3 Billion—Escalated Acquisition Costs in FY 1983 Dollars

DP 0.030

**CHART 57**

**To accomplish this, we operate major facilities at several sites, including the production reactor feed plants at Fernald and Ashtabula, Ohio, and Oak Ridge, Tennessee; the N Reactor, a fuel fabrication plant, a chemical processing plant, and other support facilities at Richland, Washington; three nuclear materials production reactors, two chemical processing plants, a fuel fabrication plant, and other support facilities at Savannah River, South Carolina; and a chemical processing plant and support facilities at Idaho Falls, Idaho. Operations at Idaho include receipt, storage, and processing of fuels both from Navy propulsion reactors and government and civilian test reactors for recovery and reuse of the remaining enriched uranium.**

## DEFENSE PROGRAMS — NUCLEAR MATERIALS

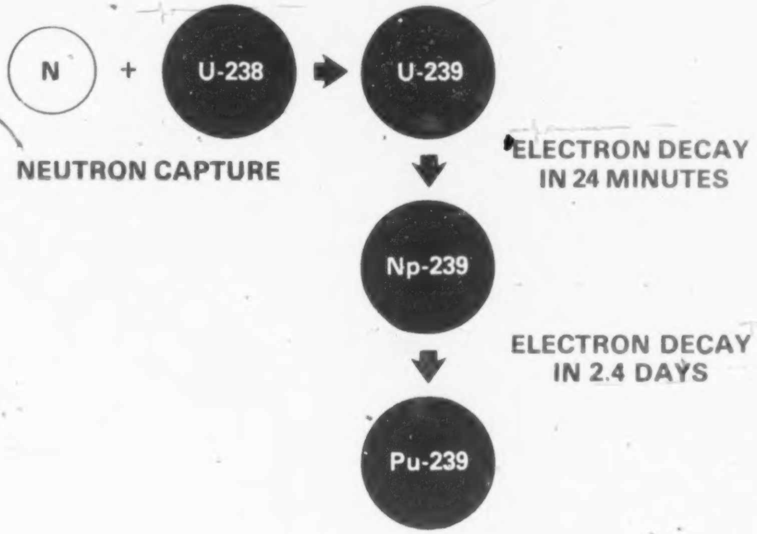

N
+
U-238
U-239
NEUTRON CAPTURE
ELECTRON DECAY IN 24 MINUTES
Np-239
ELECTRON DECAY IN 2.4 DAYS
Pu-239

CHART 58

The basic nuclear process for producing plutonium-239 is the capture of a neutron by uranium-238 in a nuclear materials production reactor to give uranium of atomic weight 239 which decays to plutonium-239, within a few days, by electron emission.

# DEFENSE PROGRAMS — NUCLEAR MATERIALS

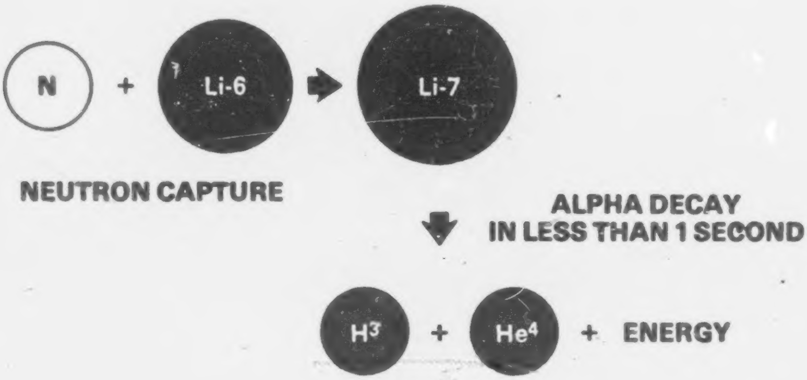

N
+
Li-6
Li-7
NEUTRON CAPTURE
ALPHA DECAY
IN LESS THAN 1 SECOND
H3
+
He4
+ ENERGY

CHART 59

The fundamental method for producing tritium, hydrogren-3, in a reactor is the capture of a neutron by lithium-6 which decomposes to give tritium and helium as a byproduct.

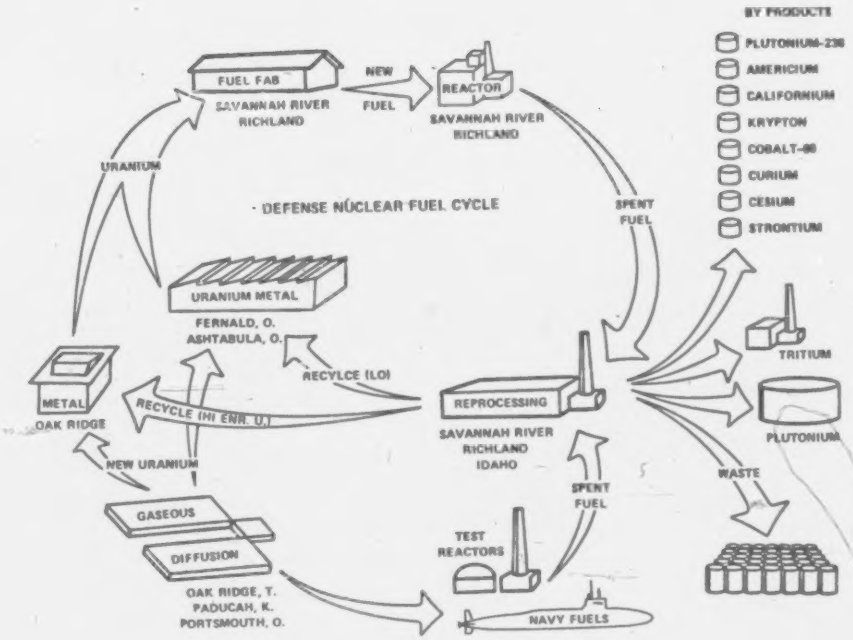
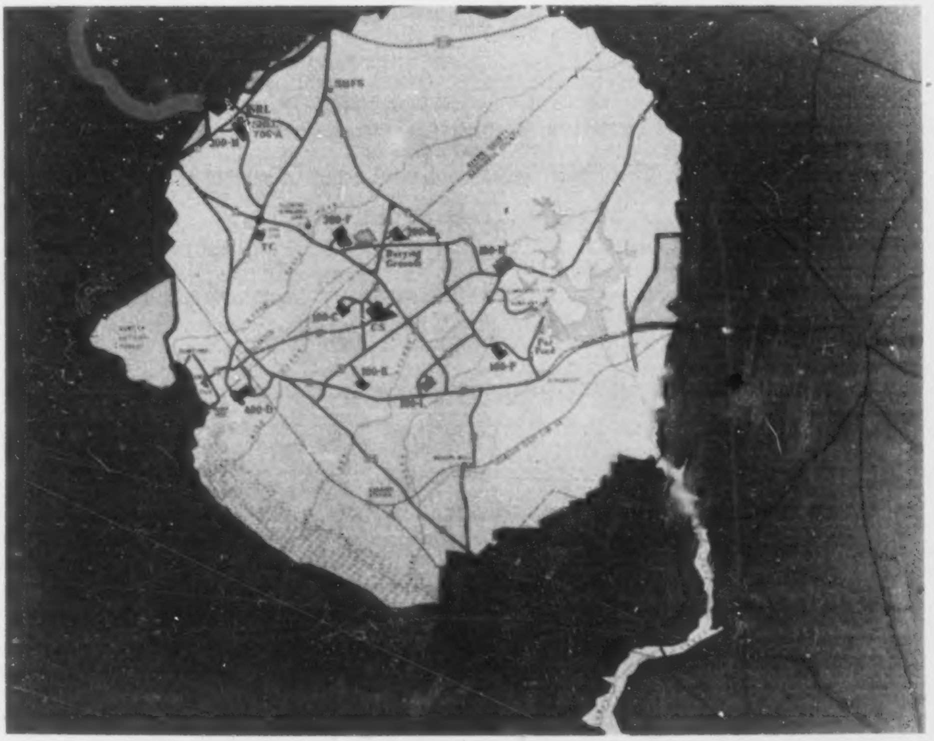

BY PRODUCTS
PLUTONIUM-238
AMERICIUM
CALIFORNIUM
KRYPTON
COBALT-60
CURIUM
CESIUM
STRONTIUM
FUEL FAB
SAVANNAH RIVER
RICHLAND
NEW
FUEL
REACTOR
SAVANNAH RIVER
RICHLAND
URANIUM
DEFENSE NUCLEAR FUEL CYCLE
SPENT
FUEL
URANIUM METAL
FERNALD, O.
ASHTABULA, O.
TRITIUM
METAL
OAK RIDGE
RECYLCE (LO)
RECYCLE (HI ENR. U.)
REPROCESSING
SAVANNAH RIVER
RICHLAND
IDAHO
PLUTONIUM
NEW URANIUM
SPENT
FUEL
WASTE
GASEOUS
DIFFUSION
TEST
REACTORS
OAK RIDGE, T.
PADUCAH, K.
PORTSMOUTH, O.
NAVY FUELS

CHART 60

The defense nuclear fuel cycle is as depicted on this chart. The enriched uranium to fuel our reactors comes from three sources: (1) uranium recovered from the spent fuel itself after it has been burned in the production reactors; (2) spent Navy and R&D reactor fuel processed at Idaho or Savannah River; and (3) inventory. The uranium is blended to the proper enrichment at Oak Ridge and shipped to Savannah River and Richland where it is fabricated into fuel rods for insertion into the reactors.

The Savannah River reactors use about 60 percent enriched uranium in the fuel to drive the reactors with physically separate depleted uranium target slugs in which plutonium is bred. The fuel rods as well as the target rods are processed at Savannah River to recover the uranium and the plutonium. Tritium is produced at Savannah River by lithium loaded target rods which can be placed in the reactor in lieu of the depleted uranium rods. [Deleted.]

The N Reactor at Richland uses slightly-enriched uranium fuel containing about 1 percent fissile uranium-235 to power the reactor and about 99 percent uranium-238 to produce plutonium. The spent fuel from N Reactor is now being stored in water basins at the reactor site pending restart of the PUREX fuel processing plant at Hanford. The plant is scheduled for April 1984 restart, but the amended FY 1983 request will permit advancing that startup date by as much as six months.



This is a map of the Savannah River Plant site. The 192,000 acre site is spread over parts of three South Carolina counties and is 12 miles south of the City of Aiken and 15 miles southeast of the City of Augusta, Georgia. The plant is operated by the DuPont Company. Major facilities at Savannah River include three operating reactors, two processing canyons, the Savannah River Laboratory, two standby reactors—L and R—and support facilities. L Reactor is currently being upgraded for restart in FY 1984.

[Chart 62 deleted.]

This is a picture of the C Reactor and its support facilities. The ponds in the foreground provide cooling water for the facility during operation.

[Chart 63 deleted.]

This slide provides a schematic representation of a Savannah River reactor. About one-fourth of the structure is below ground and inaccessible for maintenance during reactor operation because of radioactivity levels.

The reactor consists of a large shielded stainless steel tank filled with heavy water moderator to slow down the neutrons. Inserted into the heavy water are more than 600 fuel and target elements in specified configurations. Heat generated by nuclear fission is removed by circulating heavy water coolant in a closed loop through the fuel and target elements, through heat exchangers, and back into the reactor. The heat exchangers are cooled by river water which is discharged back to the environment via on-site ponds and streams.

[Chart 64 deleted.]

This is a picture of a Savannah River chemical processing plant which we call a canyon. Plutonium processing is a chemical separations activity where the

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targets are dissolved and the uranium and plutonium extracted through solvent extraction techniques. The recovered plutonium is put in the form of metal buttons which are then shipped to the weapons plants for fabrication into weapon components.

[Chart 65 deleted.]

This is a view of a canyon interior. The picture was taken during initial construction and installation of equipment about 25 years ago. Al equipment removals and installations are done remotely through the use of a shielded crane. Above the canyon is a crane with a shielded cab to protect the operator from exposure to radiation. The operator uses a periscope to perform his operations.

[Chart 66 deleted.]

Production operations at the Hanford site near Richland, Washington, are primarily conducted by two contractors: United Nuclear Corporation fabricates fuel for N Reactor and is responsible for reactor operation, maintenance, engineering and development; and Rockwell Hanford Operations provides support facilities for the entire site and will be responsible for operation of PUREX.

Major Materials Production facilities at the site include the N Reactor, the PUREX Fuel Professing Facility, the Plutonium Finishing Plant (Z-Plant), the N Reactor fuel fabrication facility, and miscellaneous support facilities.

[Chart 67 deleted.]

This is a picture of the N Reactor located at Richland, Washington. The N Reactor [deleted] delivers by-product steam to the Washington Public Power Supply System to generate up to 4 billion kilowatt-hours of electricity for the Bonneville Power Administration power grid. The estimated revenue for fiscal year 1983 of $38.0 million for steam will go to the U.S. Treasury. These revenues are not included in our budget. This reactor will be converted from production of fuel-grade to weapon-grade plutonium in 1983.

[Chart 68 deleted.]

This is a picture of the PUREX Fuel Processing Plant at Richland, Washington. This plant is currently in standby condition. The FY 1983 budget request includes third year funding to continue the upgrading needed for reactivation of this plant and its supporting facilities at Richland.

Our major Nuclear Materials Production facilities at the Idaho National Engineering Laboratory site are the Idaho Fuels Processing Facility, the Fluorinel

IDAHO NATIONAL ENGINEERING LABORATORY
LEGEND
TEST AREA NORTH (TAN)
LOFT
TERRETON
N
ANL-W
EXPERIMENTAL FIELD STATION
IDAHO CHEMICAL PROCESSING PLANT
TRA
SPERT
ARA
STATE OF IDAHO

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Dissolution Process Facility, which contains the Rover Fuel Processing Facility, and miscellaneous support and analytical facilities, all of which are operated by Exon Nuclear Corporation.

[Chart 70 deleted.]

This is a picture of the Idaho Fuels Processing Facility. The primary mission of this facility is to process spent fuel received from Navy nuclear vessels. The recovered enriched uranium is recycled as fuel into the Savannah River reactors for their operation. The Idaho Fuels Processing Facility also processes fuels from research and development and other test reactors.

## NUCLEAR MATERIALS REQUIREMENTS

[Chart 71 deleted.]

The agency's tritium and plutonium production commitment is primarily to fulfill the projection of the U.S. nuclear weapons requirements as reflected in the Nuclear Weapons Stockpile Memorandum submitted to the President annually for approval. The FY 1983 Stockpile Memorandum was signed by President Reagan on March 17, 1982. This memorandum contains stockpile projections for planning purposes through FY 1997. As I mentioned earlier, our program is designed to meet the requirements of this new Stockpile Memorandum, and our FY 1983 Appropriations request [deleted] before you are all needed to carry out the program I am about to discuss with you.

Most of the nuclear materials required for building new warheads are obtained by reclaiming and recycling existing materials from retired weapons returned by the Department of Defense. However, weapon requirements which cannot be met from the Department of Defense returns or existing agency inventories must be satisfied by new production.

[Charts 72–76 deleted.]

[Deleted.]

This chart summarizes the fuel-grade plutonium supply and demand for the weapon program based on the FY 1983 Nuclear Weapons Stockpile Memorandum. Fuel-grade plutonium is required for blending with higher purity plutonium, and for purification through a special isotope separation facility, to produce more weapon-grade material. [Deleted.]

## PRODUCTION INITIATIVES

Each of these initiatives plays an important role in the production program.

### NUCLEAR MATERIALS PRODUCTION
### BUDGET SUMMARY
### (DOLLARS IN MILLIONS)

| | FY 1982 | | FY 1983 Request | |
|---|---|---|---|---|
| | Auth. as Enacted | Approp. Inc. Sup. | Auth. as Amended | Approp. as Amended |
| Base | $ 771.9 | $ 649.2 | $ 772.4 | $ 781.2 |
| Production Initiatives (FY 1981/82) | | | | |
| Restoration | 149.6 | 71.2 | 62.1 | 111.4 |
| L Reactor Upgrade | 82.0 | 62.5 | 40.7 | 74.2 |
| Increased PU Production (Blending) | 24.2 | 24.2 | 91.5 | 45.5 |
| Special Isotope Separation | 53.4 | 46.2 | 32.8 | 40.0 |
| Purex | 46.9 | 48.8 | 64.4 | 67.1 |
| N Reactor Increased Production Options | 17.1 | 29.9 | 57.7 | 57.7 |
| New Production Reactor | 12.7 | 2.7 | 2.0 | 2.0 |
| Expansion & Mods. of Existing Fuels Processing Facility | — | 3.0 | 18.1 | 18.1 |
| High Productivity Core Loading (MK-15) | — | 3.2 | 46.5 | 31.4 |
| | $1,157.8 | $ 940.9 | $1,188.2 | $1,228.6 |

CHART 77

In FY 1981 Congress authorized and appropriated funds to initiate several new plutonium activities. The new initiatives being vigorously pursued in FY 1982 and continued into FY 1983 include: the Facility Restoration Program to upgrade the nuclear materials production complex; Special Isotope Separation research and development; PUREX upgrading; conversion of N Reactor to weapon-grade plutonium production; and a new production reactor. Also in FY 1982 at either Savannah River or Richmond, we propose to initiate conceptual engineering for expansion and modification of existing fuel processing capabilities.

## RESTORATION PROGRAM

The Restoration Program is being undertaken to improve the reliability and efficiency of the materials production complex. Much of the production complex has been in continuous use for 25 to 30 years. As a result of aging and use, many facilities, systems, and components have gradually worn out, deteriorated, or become obsolete, [deleted]. A study was therefore directed to determine what measures were required to restore the production complex to satisfactory condition and a plan was submitted to Congress in June 1979 covering the implementation of all needed corrections.

Initial funds for program implementation were provided by FY 1981 and FY 1982. A total of $187 million was authorized over these two years and work is currently underway on Phases I and II of the program. In FY 1983 we are requesting $62.1 million in authorization and $111.4 million in appropriations to continue ongoing activities and to initiate Phase III of the program.

The estimated cost of the nuclear materials production Restoration Program remains unchanged at $420 million in constant year dollars. In deferrence to budget austerity, the program in FY 1982 is being incrementally funded over a seven year period rather than the five years originally planned. All unfunded subprojects have been reprioritized to assure that those tasks that are most pressing are included in FY 1983. The amended FY 1983 budget provides for return of the Restoration Program to a six year schedule.

Apart from the materials available from retired weapons which meet a great deal of the weapon need, the plants being restored under this program are the only available sources of supply for meeting the demands for nuclear materials for weapons fabrication and energy research and development programs. It is essential that they continue to operate safely and reliably.

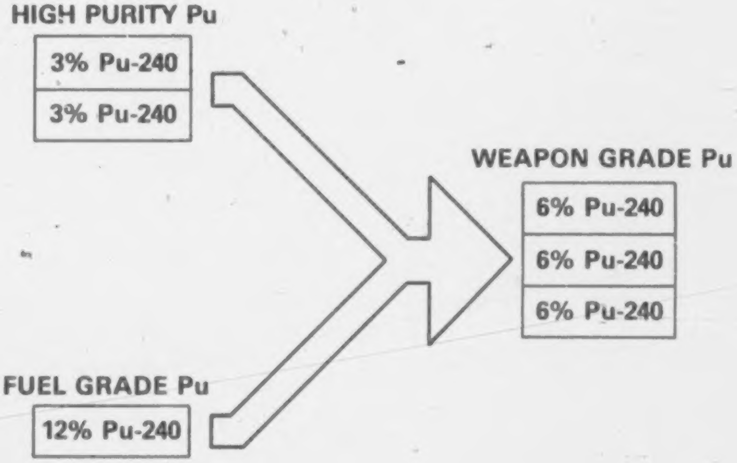
## L REACTOR UPGRADE

The L Reactor upgrade program was initiated in FY 1981 and continued in FY 1982. This upgrading is on schedule for completion by October 1983.

Since the L Reactor was shut down in 1968, many capital projects have been undertaken to improve the safety and efficiency of the remaining three operating reactors at Savannah River. These changes will be incorporated into L Reactor to bring it to condition equivalent to that of the operating reactors.

## DEFENSE PROGRAMS — NUCLEAR MATERIALS

### BLENDING



HIGH PURITY Pu

3% Pu-240

3% Pu-240

WEAPON GRADE Pu

6% Pu-240

6% Pu-240

6% Pu-240

FUEL GRADE Pu

12% Pu-240

CHART 78

The production of high-purity plutonium (3 percent Pu–240) will be continued in FY 1983 at Savannah River for blending with existing fuel-grade plutonium (12 percent Pu-240) from Richland. This program, initiated in FY 1981 and continued in FY 1982, provides for the production and fabrication of additional targets for the production of the high-purity plutonium and for target storage basin modifications necessary to handle the increased volume of irradiated plutonium targets. Production of high-purity plutonium requires essentially twice the reactor throughput of targets compared to production of weapon-grade plutonium.

[Deleted.]

## SPECIAL ISOTOPE SEPARATION

The FY 1983 budget provides for continuation of the Special Isotope Separation (SIS) R&D program for plutonium. This R&D program supports the option of using isotopic enrichment to convert fuel grade plutonium from existing Government inventories into weapons grade plutonium.

[Deleted.]

An isotope separation plant also would be able to "clean-up" the existing weapon-grade plutonium stockpile by the removing of undesirable plutonium isotopes Pu-240 and Pu-241 that are the major sources of radiation emanating from plutonium. This would reduce the radiation exposure to Defense Programs and contractor personnel who manufacture or handle nuclear weapons and to the DOD personnel who deploy these weapons.

In addition, a Special Isotope Separation production plant would be cost effective for separating non-fissile isotopes of plutonium such as Pu-238, Pu-240, and Pu-242. [Deleted.]

[Deleted.]

## PUREX

[Deleted.] The plant upgrading cell-by-cell repair, checkout and operability testing of all process systems. Three separate facility and safety assessments and maintenance and operability testing to date indicate that PUREX can safely and reliably begin operations ahead of schedule.

## N REACTOR

The budget provides the third year funding increment for converting the reactor from fuel-grade to weapon-grade plutonium production. N Reactor has already produced some 6 percent plutonium in FY 1982. During FY 1982 using Supplemental funding, the procurement of zirconium for fuel fabrication cladding will be accelerated to support the increased fuel fabrication required to continue N Reactor to a weapon-grade mode of operation. The fuel throughput for weapon-grade plutonium production is more than double that to produce fuel-grade plutonium. In FY 1983, the Budget Amendment will allow application of further increased production options such as production of 5% Pu-240 plutonium and/or operation at higher power, both of which will result in the increased production [deleted].

## NEW PRODUCTION REACTOR

Efforts planned for FY 1983 include contractor(s) selection, initiation of functional design and analysis, conceptual design, and evironmental assessments. These activities could lead to Title I design in FY 1984, start construction in FY 1985, and production operation in FY 1982.

The New Production Reactor would produce reactor products for national defense; one important product is tritium. The cessation of tritium production would have an adverse impact on our total stockpile yield. Also it has been the policy of the DOE to use departmental facilities to produce reactor products.

## EXPANSION AND MODIFICATION OF EXISTING FUELS PROCESSING FACILITY

Existing fuel processing facilities do not have capability for recovering plutonium from specially clad nonproduction fuels, i.e., certain spent fuels from research and test reactors. Substantial quantities of nonproduction reactor fuel exist, such as FFTF fuel. A processing capability in the late 1980's for these spent fuels will permit this valuable material to be recovered and reused. Conceptual design of a facility, enabling one of the defense reprocessing facilities to handle nonproduction fuels, will be initiated in FY 1982 with supplemental funding. The facility would be located adjacent to existing processing facilities, either at Richland or Savannah River. The plutonium recovered from processing nonproduction but government-owned reactor fuel would be used to meet breeder program needs or as a source for future weapon program requirements.

## FY 1981 ACCOMPLISHMENTS

Program accomplishments during FY 1981 include the following. We produced the required plutonium and tritium for national defense at levels exceeding our FY 1981 plan. We began new initiatives to increase production of nuclear materials by [deleted] converting Savannah River reactors to high purity plutonium production for blending; initiating materials production complex restoration; beginning L Reactor upgrade for restart; beginning reactivation of the PUREX processing plant; and beginning conversion of N Reactor to weapon-grade plutonium production. We operated the nuclear materials production complex in a safe, secure and environmentally sound manner. We supplied byproduct nuclear isotopes to meet R&D and commercial requirements, for example, tritium, Americium-241, and Krypton-85.

## FY 1982 PLANNED ACTIVITIES

Our planned activities for FY 1982 include the following. We will produce the planned quantities of plutonium, tritium, and other nuclear materials for national security, other Agency R&D programs, and commercial applications.

[Deleted] The initiatives begun in FY 1981 to increase the production of nuclear materials will be continued.

## BUDGET REQUEST

### NUCLEAR MATERIALS PRODUCTION
### FY 1983 BUDGET AUTHORIZATION REQUEST
### (DOLLARS IN MILLIONS)

| | FY 1982 Auth. | Amended FY 1983 Request New Auth. |
|---|---|---|
| Operating | | |
| Reactor Operations | $ 280.6 | $ 360.5 |
| Processing of Nuclear Materials | 148.7 | 220.6 |
| Special Isotope Separation Research | 30.0 | 23.0 |
| Supporting Services | 171.3 | 242.0 |
| Program Direction | 1.8 | 2.1 |
| Total Operating | 632.4 | 848.2 |
| Capital Equipment | 73.6 | 107.7 |
| Construction | 451.8 | 232.3 |
| Grand Total | $1,157.8 | $1,188.2 |

CHART 79

Our FY 1983 amended budget request of about $1.2 billion for the Materials Production program includes $848 million for operating expenses, $108 million for capital equipment, and an appropriations request for $272 million for construction, $68 million of which is for new construction projects. $232 million in new authorization is needed to support this construction activity. The FY 1982 Supplemental Request I have mentioned includes $36.5 million for this program.

# DEFENSE PROGRAMS - MATERIALS PRODUCTION

## MATERIALS PRODUCTION
### FY 1983 BUDGET REQUEST
### NEW CONSTRUCTION PROJECTS (DOLLARS IN MILLIONS)

| | | Total Estimated Cost* | New Auth. | Amended Approp. Request |
|---|---|---|---|---|
| 83-D-135 | General Plant Projects, Various Locations | $26.0 | $26.0 | $26.0 |
| 83-D-136 | Plant Engineering & Design | 2.0 | 2.0 | 2.0 |
| 83-D-138 | Purex Canyon and Dissolver Filter Systems Improvements, RL | 12.8 | 4.3 | 4.3 |
| 83-D-142 | Fuel Dissolver Off-Gas Transfer and Treatment System, ID | 7.6 | 7.6 | 3.5 |
| 83-D-146 | Water Pollution Control, FMPC, OR | 9.5 | 9.5 | 1.4 |
| 83-D-147 | Pollution Discharge Elimination, SR | 9.4 | 1.0 | 1.0 |
| 83-D-148 | Non-Radioactive Hazardous Waste Management, SR | 19.9 | 1.0 | 1.0 |
| 83-D-180 | Facility Storage Modifications, VL | 16.3 | 16.3 | 9.3 |
| | Subtotal | | $67.7 | $48.5 |

*EXCLUDES PE&D

CHART 80

# DEFENSE PROGRAMS - MATERIALS PRODUCTION

## MATERIALS PRODUCTION
### FY 1983 BUDGET REQUEST
### CONTINUING CONSTRUCTION PROJECTS (DOLLARS IN MILLIONS)

| | | | Thru FY 1982 | | FY 1983 | |
|---|---|---|---|---|---|---|
| | | Total Estimated Cost* | Author. | Approp. | Author. | Amended Approp. |
| 82-D-124 | Restoration of Production Capabilities, Phases II and III, VL | $212.2 | $126.0 | $ 47.0 | $ 48.5 | $ 87.7 |
| 82-D-126 | Reactor Safety and Reliability, VL | 61.6 | 42.9 | 6.0 | 18.7 | 7.0 |
| 82-D-136 | Fuel Processing Facilities Upgrade, IFPF, INEL, ID | 46.0 | 40.0 | 14.0 | 6.0 | 14.0 |
| 82-D-201 | Special Plutonium Recovery Facility, JB Line, SR | 64.0 | 2.0 | – | 62.0 | 16.0 |
| 81-D-126 | Pollution Abatement Facilities – Chemical Processing Plants, RL | 5.3 | 5.3 | 2.6 | – | 2.7 |
| 81-D-128 | Restoration of Production Capabilities, Phase I | 50.4 | 50.4 | 40.3 | – | 10.1 |
| 81-D-131 | Remote Analytical Facility Upgrade and Expansion, ID | 28.5 | 28.5 | 18.0 | – | 8.5 |
| 81-D-142 | Steam Transfer Header, SR | 18.4 | 8.0 | 6.6 | 10.4 | 5.5 |
| 81-D-143 | L Reactor Upgrade, SR | 134.0 | 115.0 | 81.6 | 19.0 | 52.6 |
| 81-T-502 | Advanced Isotope Separation Laboratory, LLNL** | 25.0 | 21.2 | 16.0 | – | 7.2 |
| 80-AE-2 | Replace Obsolete Processing Facilities, HB Line, SR | 19.0 | 19.0 | 16.0 | – | 3.0 |
| 77-13-A | Fluorinel Dissolution Process and Fuel Receiving Improvement, ID | 199.4 | 199.4 | 189.4 | – | 10.0 |
| | SUBTOTAL | | | | $164.6 | $224.2 |
| | GRAND TOTAL | | | | $232.3 | $272.7 |

*Excludes PE&D

**$1.8M Appropriated in the Uranium Enrichment Appropriation; $2M Appropriated to Materials Production in FY 1981. Authorized Project 82-D-202, $16M Appropriated in FY 82.

CHART 81

These charts list the individual construction projects included in our request. Now I would like to turn to the Defense Nuclear Waste Management program.

### DEFENSE NUCLEAR WASTE AND BYPRODUCTS MANAGEMENT

The Defense Nuclear Waste and Byproducts Management program provides for the management of radioactive wastes, generated primarily by the defense activities of the Agency, in particular nuclear material production and weapon production. It also includes research and development of technologies for the disposal of these wastes and beneficial applications of recovered materials.

## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

**GOAL:** **Assure That Nuclear Wastes Are Safely Handled, Treated, Stored or Utilized, Transported and Disposed of to Protect the Public Health and Safety**

**OBJECTIVES:**

- **Provide for Safe Utilization or Interim Storage of Wastes;**
- **Develop Alternative Technologies and Processes to Support Final Disposal;**
- **Develop an R&D Facility to Demonstrate Geologic Disposal of Defense Wastes;**
- **Test Transportation Systems to Safely Carry Defense Generated Wastes; and**
- **Clean up Surplus Facilities From Defense Activities to Recover Materials and Prepare for Reuse.**

**CHART 82**

The primary goal of the program is to utilize, or dispose of, nuclear wastes routinely, safely, and effectively. This goal will be achieved when there is no need to add to the inventories of stored waste for lack of a disposal system.

The second goal is to deal with the inventory of wastes and facilities from the past. This goal will be achieved when the inventory is reduced to normal operational levels and the backlog dealt with for the long-term, either by immobilization and disposal or by stabilization in place.

## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

### Defense Waste Inventory

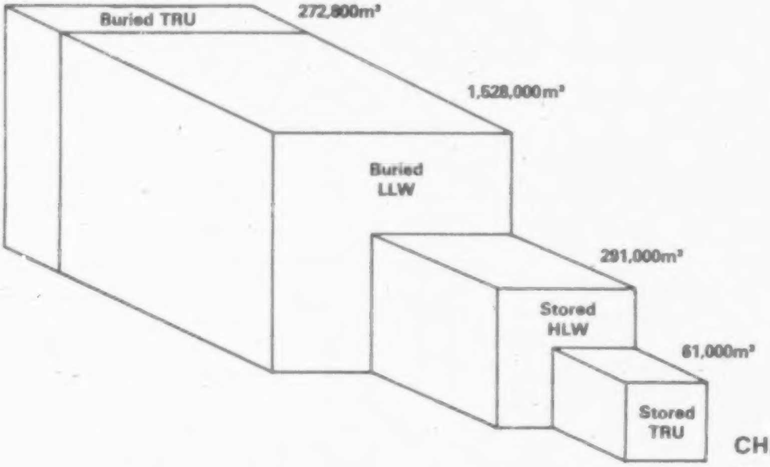


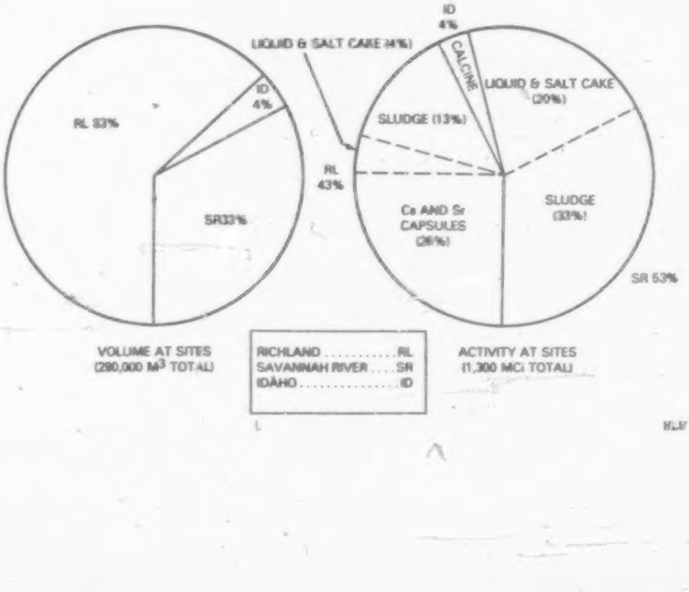
CHART 83

GEMP 13 022

The inventory of defense wastes and their relative amounts are shown in Chart 83. As you will note, the largest inventory of waste is low-level for which the fuel cycle is closed through shallow-land burial. We are addressing the long-term solution for high-level and transuranic waste.

## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

### DOE DEFENSE HIGH-LEVEL WASTE INVENTORY



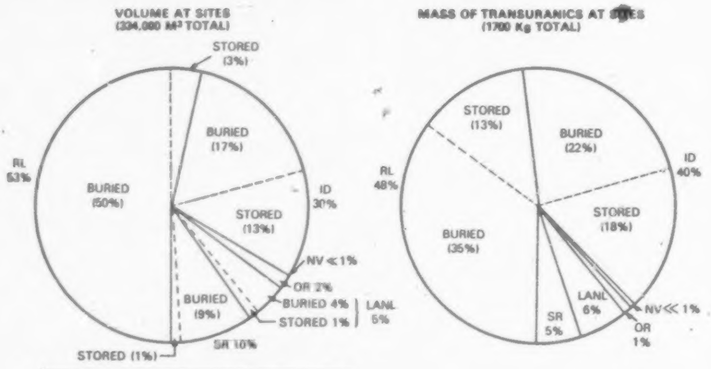
HLW 11 020

CHART 84

Chart 84 shows the location of high-level wastes stored in tanks and bins. Although Richland has the greatest volume of waste, there is more radioactivity at Savannah River because we are producing new waste there.

## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

### DOE DEFENSE TRANSURANIC WASTE INVENTORY



| SITE | % OF STORED | % OF BURIED |
|---|---|---|
| IDAHO (ID) | 69 | 21 |
| RICHLAND (RL) | 17 | 61 |
| LOS ALAMOS (LANL) | 7 | 4 |
| SAVANNAH RIVER (SR) | 4 | 12 |
| OAK RIDGE (OR) | 2 | 2 |
| NEVADA (NV) | 1 | < 1 |
| TOTALS | 61,000 M³ | 273,000 M³ |

EXCLUDES: HIGH-LEVEL WASTE (830 Kg)
SURPLUS FACILITIES (50 Kg)

TRU 11 004

**CHART 85**

Chart 85 shows the location of stored and buried transuranic waste. Again, Richland has the greatest volume of waste, but Idaho's waste has about the same content of radioactive material and the largest volume of stored waste.

### INTERIM WASTE OPERATIONS

In meeting our responsibilities for providing safe handling and interim storage or disposal of radioactive byproducts and waste resulting from defense activities, the Interim Waste Operations activity has achieved several major accomplishments. Specifically, by the end of FY 1981, the free-standing liquid had been pumped out of all 149 singe-shell tanks at the Hanford Site at Richland, Washington, significantly decreasing the potential for leaks from these tanks [chart 86 deleted]; seven new double-shell tanks at Hanford were put into operation, providing additional waste storage capability; and 14 single-shell tanks at Hanford had been isolated to prevent the intrusion of liquid. In addition, construction of the New Waste Calcining Facility and the fifth set of calcined solids storage bins at the Idaho National Engineering Laboratory were completed.

So far in FY 1982, we have completed the construction of the New Hydrofracture Facility at Oak Ridge, Tennessee, which will be used to inject a mixture [chart 87 deleted] of intermediate-level waste and cement into the shale formation underlying Oak Ridge National Laboratory, and we have completed 18 new double-shell tanks at Savannah River, South Carolina, which are needed to complete the program for transfer of waste from the older tanks. In the remaining months of FY 1982, we will begin hot operations of the New Hydrofracture Facility at Oak Ridge and the New Waste Calcining Facility at Idaho.

In 1983, Interim Waste Operations activities which support the Waste Isolation Pilot Plant project and the Defense Waste Processing Facility will become more prominent in our program. Specifically, we will begin developing procedures at all sites to certify newly generated transuranic waste as being acceptable for emplacement at the Waste Isolation Pilot Plant in New Mexico. Waste in retrievable storage will also be addressed at some of the storage sites in 1983. Efforts will continue to develop the processing design, construction and equipment installation for transfering high-level waste from old single-shell tanks to new double-shell tanks at Savannah River. In addition, at Savannah River we will demonstrate an in-tank precipitation process for the removal of cesium from the salt. If successful, this byproduct will be available for subsequent use, eliminating the need for a second stage of the Defense Waste Processing Facility, and greatly reducing future costs. At Hanford, we will begin the construction of six double-shell tanks for high-level waste and will increase waste evaporator operations as included in the Supplemental and Budget Amendment requests to prepare for the startup of the PUREX fuel reprocessing plant in fiscal year 1984. We will also continue efforts at Hanford to stabilize and isolate the old single-shell tanks and transfer waste to new double-shell tanks.

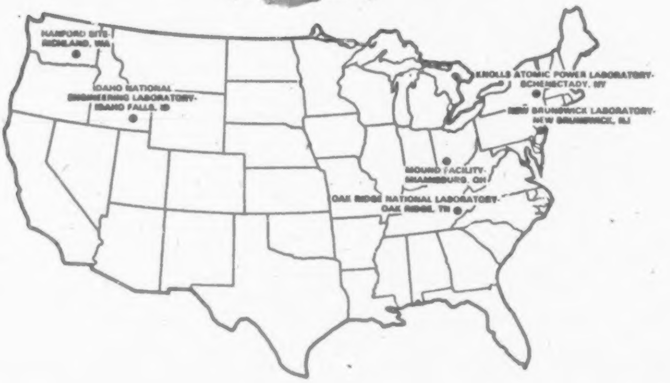
Under our landlord responsibilities, we will continue efforts begun in fiscal year 1981 at Hanford to restore general support facilities and equipment to an acceptable level of safety, reliability, and efficiency. With the transfer of Idaho landlord to Defense Waste Management in fiscal year 1983, we are supporting general site support efforts there also.

### DECONTAMINATION AND DECOMMISSIONING

We have responsibility for the decontamination and decommissioning of about 400 [chart 88 deleted] surplus defense facilities including reactors, reprocessing plants and waste facilities. The locations of these facilities are shown on this map.

## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

### LOCATIONS OF DOE RADIOACTIVELY CONTAMINATED SURPLUS FACILITIES (DEFENSE)



D&D 01 036

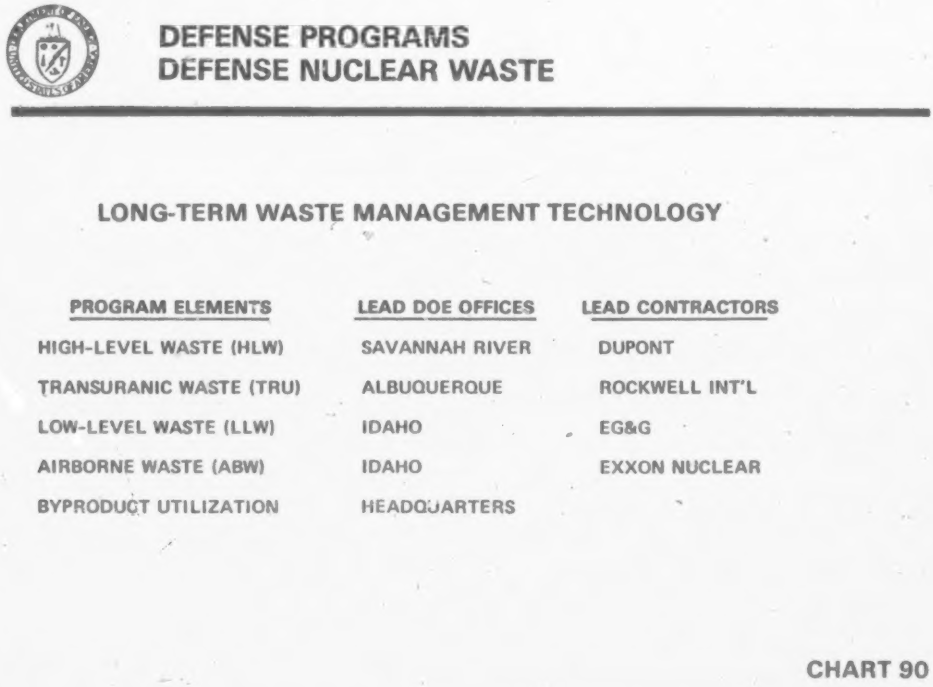
CHART 89

We have reoriented this program for FY 1983. As in the past, all facilities will be maintained in an occupationally and environmentally safe condition. Where it is determined to be cost effective, program priorities in FY 1983 will also stress beneficial reuse of existing structures and recovery of valuable materials while reducing future maintenance costs.

In FY 1982, only a minimal program of surveillance and maintenance will be provided. The increased funding in FY 1983 will provide an adequate level of maintenance and surveillance for all defense-related surplus facilities and permit the implementation of beneficial reuse programs at Hanford, the Mound Facility, the New Brunswick Laboratory site, and the Idaho site.

### LONG-TERM MANAGEMENT TECHNOLOGY

The goal of this technology program is to define, evaluate, and implement solutions for the long-term management and disposal of the Agency's defense-related radioactive wastes and for the utilization of waste byproducts. Major considerations in the selection and implementation of these alternatives include the impact to public health and the environment, and overall costs. We are preparing a defense waste plan in response to Section 213 of the 1982 Authorization Act, P.L. 97–90. This plan, which will cover our long-term strategy for each site, will be forwarded to Congress in June 1983 by the President.



## DEFENSE PROGRAMS
## DEFENSE NUCLEAR WASTE

### LONG-TERM WASTE MANAGEMENT TECHNOLOGY

| PROGRAM ELEMENTS | LEAD DOE OFFICES | LEAD CONTRACTORS |
|---|---|---|
| HIGH-LEVEL WASTE (HLW) | SAVANNAH RIVER | DUPONT |
| TRANSURANIC WASTE (TRU) | ALBUQUERQUE | ROCKWELL INT'L |
| LOW-LEVEL WASTE (LLW) | IDAHO | EG&G |
| AIRBORNE WASTE (ABW) | IDAHO | EXXON NUCLEAR |
| BYPRODUCT UTILIZATION | HEADQUARTERS | |

CHART 90

In order to decentralize management in this area, we have established lead field offices, supported by lead contractors, with responsibility for the technology program associated with each type of radioactive waste. These organizations provide overall planning, direction, and assessment of technology development.

### HIGH-LEVEL WASTE

In the High-Level Waste Technology program, we are developing the technology required for long-term management of defense high-level waste at the individual Agency sites. The program now is focusing on implementation of the selected waste processing strategy at Savannah River, while continuing development of options appropriate for the wastes at the Richland and Idaho sites.

During FY 1982 the number of alternative waste forms being evaluated for the DWPF at Savannah River has been reduced from seven to two [chart 91 deleted]: the reference form, borosilicate glass, and a crystalline-ceramic form. We expect to select a final waste form during FY 1982.

During FY 1983, the High-Level Waste program will focus on the technology required for the Defense Waste Processing Facility design and construction at Savannah River [chart 92 deleted]. Full scale tests will be performed using simulated waste to demonstrate the reliability of the glass-melter and support systems, including slurry feed transfer, off-gas and process controls. Testing of hot-cell processes wil continue using actual Savannah River Plant high-level waste, and process data will be developed for the Defense Waste Processing Facility design and construction.

### DEFENSE WASTE PROCESSING FACILITY

The Defense Waste Processing Facility provides an essential step in the processing of defense waste for ultimate disposal. The facility will immobilize defense high-level waste at Savannah River in a form suitable for transportation to a permanent disposal in a federal repository. Immobilization of the high-level waste and confinement in a geologic repository will insure the long-term isolation of the waste from the human environment with minimal maintenance and surveillance.

This project provides for construction of facilities to solidify the sludge fraction of the high-level waste which contains most of the hazardous radionuclides and virtually all of the long-lived activity. Facilities will be constructed later, if required, to process the soluble salt fraction of the waste inventory and separate radioactive cesium which can be purified for use as a beneficial by-product. The Defense Waste Processing Facility process will separate, where practical, other useful materials from the waste such as mercury and noble metals.

Design of the Defense Waste Processing Facility began in FY 1979 and will continue through FY 1983, leading to the start of construction in early FY 1984. In FY 1982, the project Environmental Impact Statement will be published. The waste form (borosilicate glass or crystalline ceramic) will be selected before the end of FY 1982. Borosilicate glass has been the reference waste form for design purposes and the evidence to date does not indicate any reason to change. Construction will be completed and hot operation will begin in FY 1990.

### TRANSURANIC WASTE

Transuranic waste is nuclear waste which contains significant quantities of long-lived elements that lie beyond uranium in the periodic table of elements. In FY 1982, we will complete generation of compliance requirements for emplacing stored, contact-handled transuranic waste in the Waste Isolation Pilot Plant. This year newly generated transuranic waste at Rocky Flats will begin to be certified to meet the Waste Isolation Pilot Plant Waste Acceptance Criteria and placed into segregated storage at Idaho. Conceptual designs will be completed for a pilot plant to examine and certify the Idaho stored waste for the Waste Isolation Pilot and an experimental pilot plant to test processing techniques for the stored wastes at Idaho [chart 93 deleted] that are not acceptable, as is, for the Waste Isolation Pilot Plant. Standardized metal box containers for contact-handled waste will be developed and qualified for meeting waste acceptance criteria. In FY 1983, the Waste Isolation Pilot Plant compliance requirements for remote-handled transuranic waste will be developed, and technology development for assay instrumentation completed. The final designs for the Stored Waste Examination Pilot Plant and the Processing Experimental Pilot Plant facilities will be completed and qualified meeting the necessary requirements. At all sites, the majority of the newly generated contact-handled transuranic waste will be certified as meeting the waste acceptance criteria and placed in interim storage separate from the other waste.

The Agency is concerned about the safe disposal of transuranic waste. The early program at Idaho to accomplish safe disposal focused on the Slagging Pyrolysis Incineration process to handle both stored and buried transuranic waste. However, there was some reservation about this incineration technology without a demonstration. Therefore, the Agency is conducting a full scale demonstration of this incineration process on non-radioactive wastes at the Reedy Creek Utilities facility [chart 94 deleted] at Lake Buena Vista, Florida, during FY 1982. The goal is to demonstrate the viability of the slagging pyrolysis incineration process for Idaho-type waste before committing to a full scale facility for radioactive waste. Activities will also be initiated on other processes (shredding, rotary kiln incineration, and cementing) for further testing on a pilot scale through the Processing Experimental Pilot Plant discussed earlier. These efforts will provide the basis for selecting the best technology for processing transuranic wastes.

### LOW-LEVEL WASTE

Since FY 1977, the Low-Level Waste Program has developed improved shallow land burial [chart 95 deleted] technology and practices. In FY 1982, documents to identify current practices and uniform criteria for shallow land burial siting, design, operations and closure, as well as environmental monitoring, will be completed.

In FY 1983, the criteria for the low-level waste itself, including waste treatment, waste handling, waste packaging, and waste form testing will be completed. Current technology for waste treatment efforts will be documented, and advanced low-level waste treatment combustion processes will be developed. Improvements to land burial technology such as water and biological intrusion barriers are being developed. Demonstration of greater confinement techniques for certain transuranic-contaminated low-level wastes will begin duirng FY 1983 with the instalation of instrumentation and caissons at the Nevada Test Site.

### AIRBORNE WASTE

The Airborne Waste program has developed and demonstrated real-time monitoring systems for gaseous and particulate effluents. During FY 1982, the development and field testing on an electrically-enhanced rolling pre-filter [chart 96 deleted] will be completed to provide prevention of filter smoke-plugging in the event of fire. The development of improved particulate air filters at Rocky Flats using fiberglass compositions ha resulted in doubling the lifetime of filters, thereby reducing replacement and disposal costs. The development of a pilot scale tritium recovery system will also be completed in FY 1982 at Mound Laboratory. In addition, airborne waste activities in FY 1983 will be completed for carbon-14 immobilization and thermal outgassing of irradiated fuels. Development of prefilters will be completed with a static permanent charger filter, and an aerosol test system that will be developed for the Filter Testing Facilities.

### BYPRODUCTS UTILIZATION

Under the Byproducts Utilization program, we are developing safe, efficient, and cost-effective applications of radioisotopes and other materials recovered from the defense nuclear fuel cycle. In FY 1982, design will be completed for a shipping cask to more cost-effectively transport cesium for food and sludge irradiation [charts 97 and 98 deleted]. Support will be provided for the design of a sludge irradiation facility for the City of Albuquerque, New Mexico. Testing of second generation long-lived krypton-tritium lights [chart 99 deleted] for airfield application particular interest in lightweight, hand-held tritium markers similar to this unit which we recently developed. During FY 1983, program efforts will continue to center on the use of cesium-137 for sewage sludge disinfection and food processing, the development of krypton-85 and tritium airfield lighting, and the recovery and use of strontium-90 for remote power applications [chart 100 deleted].

### TRANSPORTATION RESEARCH AND DEVELOPMENT

The goal of the Agency's nuclear material transportation R&D program is to assure that safe, efficient, and cost-effective transportation systems are available to meet the needs of the defense nuclear waste programs. Activities for planning, design, development and testing of transport systems, packages, materials and equipment are carried out under the following program categories: Technology Development, Testing and Operational Safety, and Accident Analysis. This R&D is conducted at the Transportation Technology Center at the Sandia Laboratory in Albuquerque, New Mexico. These activities include materials and design developments, investigations, and testing; review of facility designs to optimize transport systems interfaces; and environmental and safety analyses to comply with or address concerns with the Department of Transportation's and the Nuclear Regulatory Commission's transport system regulations.

In FY 1982, the final design and scale model testing of a truck mounted transporter for contact-handled transuranic waste (TRUPACT) [chart 101 deleted] will be completed. The conceptual design of a truck-carried high-level waste cask will be completed, and a report on the response of shipping casks to explosive devices will be issued.

In FY 1983, testing of a prototype TRUPACT will be completed, and final design will be initiated for the high-level waste cask for truck transport [chart 102 deleted]. FY 1983 tasks will also include the development of standards for containers and for the design of offsite shipping and receiving facilities, development of American Society of Mechanical Engineering Codes for equipment design; interfaces with shipping and receiving facilities, structural and thermal analysis and testing; materials properties investigations; risk assessment; and a transportation information service. Albuquerque Operations Office will continue to be the lead field office for management of the program, with Sandia Laboratories as the lead support contractor for this activity. Much of the work, however, will be carried out by industry, universities, and other national laboratories.

## TERMINAL STORAGE—WASTE ISOLATION PILOT PLANT

The Waste Isolation Pilot Plant is the key to our long-term waste management program [chart 103 deleted]. This research and development facility will demonstrate the permanent disposal of radioactive wastes from defense programs. It is exempt from licensing by the Nuclear Regulatory Commission.

The Waste Isolation Pilot Plant will demonstrate the safe handling of radioactive wastes on a credible scale, which would be typical of normal operational quantities. We are constructing a facility [chart 104 deleted] to receive, inspect, and package for emplacement both remote-handled high-level and transuranic waste, and contact-handled transuranic waste, in an environment typical to a final disposal site. The Waste Isolation Pilot Plant will demonstrate the safe handling and emplacement of wastes at the same rates at which they are being generated.

Since issuing our Record of Decision on January 22, 1981, to proceed with the Waste Isolation Pilot Plant as authorized, significant process has been made. On July 4, 1981, work was started to drill the first exploratory shaft. That shaft, 12 feet in diameter, is now completed. Its depth is 2,300 feet. A steel liner has been installed down to the salt formation (about 850 feet). Drilling of a second shaft, 6 feet in diameter, is also now complete. Its depth is 2,200 feet and it provides for ventilation and emergency exit during the exploratory program. Final design (Title II) was started in February 1981.

Under the Consultation and Cooperation Agreement, we are working closely with the State of New Mexico. An Administrative Land Withdrawal by the Department of Interior assures access to the site through the exploratory program. The requested supplemental appropriation of $5 million in fiscal year 1982 lets us acquire an additional 2,280 acres of hydrocarbon leases to protect the integrity of the site.

The FY 1983 funding will allow us to complete the exploratory phase of construction and begin construction of permanent surface and underground facilities. Major activities, besides the exploratory work, include roads, power, water, and contracts for the remaining shafts. Title II design will proceed. Funds are also included for the acquisition of hydrocarbon leases to protect the geologic integrity of the site.

We have reduced the cost of the project by about $200 million through more effective and austere construction plans. These savings will reduce our requirements beginning in fiscal year 1984 and will not affect either safety or the mission: to demonstrate the safe disposal of defense wastes, and dispel the notion that the government is unable or unwilling to resolve the nuclear waste problem.

The total FY 1983 Appropriation Request of approximately $521 million in appropriations and $501 million in new authorization for the Defense Nuclear Waste Program, includes operating funds amounting to $290 million, capital equipment funding of $31.7 million, and $200 million for construction. The FY 1982 supplemental request is for $7 million; $2 million in operating funds and $5 million in construction.

# DEFENSE PROGRAMS
# DEFENSE NUCLEAR WASTE

### DEFENSE NUCLEAR WASTE MANAGEMENT
### FY 1983 BUDGET REQUEST
(BA in Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| | AUTH. AS ENACTED | APPROP. INCL. SUPPL. | AUTH. AS AMENDED | APPROP. AS AMENDED |
| INTERIM WASTE OPERATIONS | $266.3 | $229.5* | $261.5 | $281.3 |
| DECONTAMINATION AND DECOMMISSIONING | 4.1 | 4.1 | 12.8 | 12.8 |
| LONG-TERM WASTE MANAGEMENT TECHNOLOGY | 91.9 | 81.2 | 92.3 | 92.3 |
| TRANSPORTATION RESEARCH AND DEVELOPMENT | 6.9 | 6.9 | 7.0 | 7.0 |
| TERMINAL STORAGE | 44.0 | 44.1 | 125.4 | 125.4 |
| PROGRAM DIRECTION | 1.6 | 1.6 | 2.0 | 2.0 |
| TOTAL | $414.8 | $367.4 | $501.0 | $520.8 |

*EXCLUDES $930,000 IN CAPITAL EQUIPMENT FUNDING AND $3,532,000 IN CONSTRUCTION FUNDING FOR IDAHO LANDLORD ACTIVITIES FOR COMPARABILITY PURPOSES ONLY.

**CHART 105**

## SUMMARY

In summary, I wish to reemphasize our commitment to the safe utilization, handling and disposal of Agency-generated radioactive wastes of all types. We shall also continue to upgrade the safety of facilities and to proceed with research and development at the various defense sites to safely manage nuclear waste for the long-term. This completes my formal statement, Mr. Chairman. I would be pleased to answer any questions that you may have at this time.

Mr. ROSER. I would just briefly remind the committee of the responsibilities of the defense program mission in the Department of Energy.

## DEFENSE PROGRAMS MISSION

First and foremost, of course, it is:

To design, test and manufacture all nuclear weapons;

To produce the nuclear materials required for the weapons program; and

To manage the defense wastes that are generated thereby;

To conduct the inertial fusion program in support of the Nation's military needs;

To insure the protection of special nuclear materials and all facilities;

To assist in the development of verification technology;

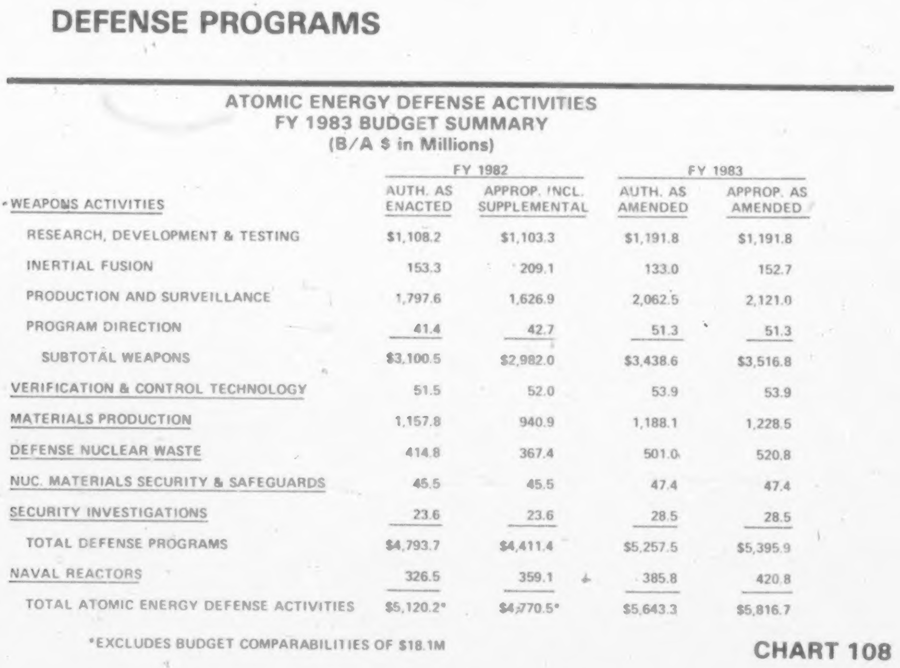
To monitor international arms agreements and to control the transfer of sensitive technology to other nations; and

To conduct a program to protect classified information.

Very briefly, since last year I have been able to put my organization in place. I have a principal deputy, Mr. Troy E. Wade, who is here with me; three Deputy Assistant Secretaries, one for military applications, Maj. Gen. William W. Hoover; one for nuclear materials, Dr. Charles Gilbert; one for security affairs, Mr. Jim Culpepper.

I am pleased to say that organization is in place and functioning well.

## DEFENSE PROGRAMS



DEFENSE PROGRAMS

ATOMIC ENERGY DEFENSE ACTIVITIES
FY 1983 BUDGET SUMMARY
(B/A $ in Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| WEAPONS ACTIVITIES | AUTH. AS ENACTED | APPROP. INCL. SUPPLEMENTAL | AUTH. AS AMENDED | APPROP. AS AMENDED |
| RESEARCH, DEVELOPMENT & TESTING | $1,108.2 | $1,103.3 | $1,191.8 | $1,191.8 |
| INERTIAL FUSION | 153.3 | 209.1 | 133.0 | 152.7 |
| PRODUCTION AND SURVEILLANCE | 1,797.6 | 1,626.9 | 2,062.5 | 2,121.0 |
| PROGRAM DIRECTION | 41.4 | 42.7 | 51.3 | 51.3 |
| SUBTOTAL WEAPONS | $3,100.5 | $2,982.0 | $3,438.6 | $3,516.8 |
| VERIFICATION & CONTROL TECHNOLOGY | 51.5 | 52.0 | 53.9 | 53.9 |
| MATERIALS PRODUCTION | 1,157.8 | 940.9 | 1,188.1 | 1,228.5 |
| DEFENSE NUCLEAR WASTE | 414.8 | 367.4 | 501.0 | 520.8 |
| NUC. MATERIALS SECURITY & SAFEGUARDS | 45.5 | 45.5 | 47.4 | 47.4 |
| SECURITY INVESTIGATIONS | 23.6 | 23.6 | 28.5 | 28.5 |
| TOTAL DEFENSE PROGRAMS | $4,793.7 | $4,411.4 | $5,257.5 | $5,395.9 |
| NAVAL REACTORS | 326.5 | 359.1 | 385.8 | 420.8 |
| TOTAL ATOMIC ENERGY DEFENSE ACTIVITIES | $5,120.2* | $4,770.5* | $5,643.3 | $5,816.7 |

*EXCLUDES BUDGET COMPARABILITIES OF $18.1M

CHART 108

Briefly, our request for funding for fiscal year 1983 amounts to a total of $5.816 billion, which includes the naval reactors program at $420 million. We have here the comparisons of those programs for fiscal year 1982, including a supplemental request which is on the Hill, endorsed by the President, and an amended request for the 1983 budget.

I will just cover the amended request very briefly:

As you can see, the research, development and testing of weapons goes up, not as much as we would like but it is up and will allow us to continue our efforts to improve the RD&T portion of our program.

Inertial fusion is down a bit, with a redirection of the program that I should like to speak to briefly later.

Production is up substantially and I will cover the requirements of the stockpile memorandum shortly. The program direction is up in order to have the people in place to support the effort.

The total weapons effort goes from some $2.9 billion in 1982 to about $3.5 billion in 1983.

In the other categories, the principal increase is in the materials production area, which goes up from $40 million to $1.228 billion. That has to do principally with the increased requirements for special nuclear materials to meet the stockpile.

The defense waste program is up because we are in a position to proceed with that program having selected a reference waste form for high-level defense waste and started construction of the waste isolated pilot plant.

The nuclear material security and safeguards program is about the same level of effort (indicating on chart) and the security investigations program, is up slightly.

### TECHNOLOGICAL PROGRESS

[Deleted.]

### WEAPON SYSTEM STATUS

The warheads which we have in production—as you can see, we are in production on six warhead systems at the present time, two tactical bombs, three missile systems and one artillery-fired atomic projectile. We are heading toward first unit production for the air-launched cruise missile warhead, and we are involved in production engineering for the submarine-launched cruise missile, a new strategic bomb, the ground-launched cruise missile, a new Pershing missile.

We are in development engineering with a nuclear standard missile or SM–2, a new 155-millimeter artillery-fired atomic projectile, and a warhead for the Pershing missile.

We are in advanced development on Sentry, low altitude defense system, and an antisubmarine warfare weapon.

We are looking at the capability to move into an advanced program on a Mark 500 Evader reentry body for the Navy.

### TESTING TRENDS

This is the history of our testing program over the past decade, divided between technology base and development engineering and certification. [Deleted.]

The systems that we are building in the production complex at the moment are those systems which were designed several years ago. We are pointing toward a more balanced program. We are beginning to make some progress and we want to continue that progress where we will have a balanced program, including technology base development and the development engineering and certification of warheads.

### INERTIAL CONFINEMENT FUSION

On the inertial confinement fusion program, we have redirected our efforts. There was some confusion for a while as to what the real objective of the inertial fusion program was. It was funded as a military program and its use is basically to perform weapons physics studies and do weapons effects simulation.

We have agreed throughout the community on a program which in essence will consist of three different approaches to inertial confinement fusion—a glass laser system, a gas laser system, and ion accelerator. We believe that this is a prudent program and we are proceeding properly with it. Obviously, as it proceeds, and as it succeeds, we will, as a byproduct, determine the potential of this technology for energy production. We believe it does have that potential, but our program is actually directed toward weapon systems.

[Deleted.]

We operate in essence four industrial complexes and we try to operate them on a businesslike basis. This does require some flexibility.

### WEAPONS PROGRAM

Here is the workload and the stockpile projected out to 1987. [Chart deleted.] This blue line is a retrofit of the W-68 Poseidon warhead. The red portion up here is the stockpile improvement program which we have just started and which we hope to pursue very vigorously. We have had some discussions with Senator Warner with respect to making sure that we improve safety features in the weapons that are at risk in standby status or in alert status. We are working on that program.

So, we are making some progress.

Very briefly, I would like to show this picture. [Chart deleted.] This is classified but we will work very hard to come up with an unclassified statement which covers this. I think Dr. Wagner has already done some work on it. We may change our classification guide just a little bit in order to show the trend of the stockpile to the general public. As you can see, even this chart does not show the dramatic decrease from the sixties into the seventies as far as total numbers in the stockpile are concerned.

[Deleted.] There is a bit of misconception on the part of the public and we believe—as Senator Warner mentioned earlier—this needs to be conveyed to the general public, to combat some of the misinformation which they have on this subject.

Here is an indication [chart deleted] and Dr. Wagner has some better charts which we may be able to show a little later—but this chart indicates the history of the yield of the stockpile [deleted].

Very briefly, I would like to show you what we have been doing with some of the money that this committee has very knowledgeably authorized to update the facilities and the production complex. This is a picture of an old chuck lathe at the Bendix Kansas City plant, and [charts deleted] a picture of a new, modern computer-controlled piece of equipment with which it has been replaced and an indication of some of the advances that we have made thereby.

### BENEFITS OF N/C

30 percent reduction in machining time.
30 percent reduction in setup time.
20 percent reduction in rework.
20 percent increase in operating efficiency.
Increased tool life.
Improved product thru-put.
Reduced scrap.

We have reduced machine time by 30 percent. We have reduced setup time by 30 percent. We have had a 20-percent reduction in rework and a 20-percent increase in operating efficiency, plus some other very cost-effective benefits.

I simply would like to say to this committee, we certainly appreciate your support of that program. We have a long way to go yet but we are making good progress in the restoration of the production complex.

## MATERIALS PRODUCTION

As far as nuclear materials are concerned, they are required, obviously, to produce weapons. [Deleted.]

One thing I think is important—this is a theoretical chart [chart deleted]; I want to be sure that you understand that—but we have indicated to this committee, and the other committees that work on our budget, the need for a replacement production reactor as a backup source of tritium.

As you can see here, in the event we were to quit producing tritium this year, the yield of the stockpile would drop [deleted].

The stockpile depends on tritium [deleted] and we must have a dependable source of tritium.

Very quickly, the nuclear materials production budget—we went through earlier all the items.

### NUCLEAR MATERIALS PRODUCTION
### BUDGET SUMMARY
### (DOLLARS IN MILLIONS)

| | FY 1982 | | FY 1983 Request | |
|---|---|---|---|---|
| | Auth. as Enacted | Approp. Inc. Sup. | Auth. as Amended | Approp. as Amended |
| Base | $ 771.9 | $ 649.2 | $ 772.4 | $ 781.2 |
| Production Initiatives (FY 1981/82) | | | | |
| Restoration | 149.6 | 71.2 | 62.1 | 111.4 |
| L Reactor Upgrade | 82.0 | 62.5 | 40.7 | 74.2 |
| Increased PU Production (Blending) | 24.2 | 24.2 | 91.5 | 45.5 |
| Special Isotope Separation | 53.4 | 46.2 | 32.8 | 40.0 |
| Purex | 46.9 | 48.8 | 64.4 | 67.1 |
| N Reactor Increased Production Options | 17.1 | 29.9 | 57.7 | 57.7 |
| New Production Reactor | 12.7 | 2.7 | 2.0 | 2.0 |
| Expansion & Mods. of Existing Fuels Processing Facility | — | 3.0 | 18.1 | 18.1 |
| High Productivity Core Loading (MK-15) | — | 3.2 | 46.5 | 31.4 |
| | $1,157.8 | $ 940.9 | $1,188.2 | $1,228.6 |

These are our new production initiatives: restoration program, start of the "L" reactor upgrade, increased plutonium production, start of Purex; expansion and modification of an existing process facility and some high productivity core loading—for a total budget of $1.2 billion.

## DEFENSE WASTE

Lastly, our defense waste budget—I won't go into detail on it, but it is moving up.

### DEFENSE NUCLEAR WASTE MANAGEMENT
### FY 1983 BUDGET REQUEST
(BA in Millions)

| | FY 1982 | | FY 1983 | |
|---|---|---|---|---|
| | AUTH. AS ENACTED | APPROP. INCL. SUPPL. | AUTH. AS AMENDED | APPROP. AS AMENDED |
| INTERIM WASTE OPERATIONS | $266.3 | $229.5* | $261.5 | $281.3 |
| DECONTAMINATION AND DECOMMISSIONING | 4.1 | 4.1 | 12.8 | 12.8 |
| LONG-TERM WASTE MANAGEMENT TECHNOLOGY | 91.9 | 81.2 | 92.3 | 92.3 |
| TRANSPORTATION RESEARCH AND DEVELOPMENT | 6.9 | 6.9 | 7.0 | 7.0 |
| TERMINAL STORAGE | 44.0 | 44.1 | 125.4 | 125.4 |
| PROGRAM DIRECTION | 1.6 | 1.6 | 2.0 | 2.0 |
| TOTAL | $414.8 | $367.4 | $501.0 | $520.8 |

*EXCLUDES $930,000 IN CAPITAL EQUIPMENT FUNDING AND $3,532,000 IN CONSTRUCTION FUNDING FOR IDAHO LANDLORD ACTIVITIES FOR COMPARABILITY PURPOSES ONLY.

We have, as I mentioned, selected a reference high level waste form and we are in the process of designing a facility to solidify the high-level waste that we have for storage at Savannah River, and we hope to get on with our program to take care of the waste which has been accumulating for a number of years.

I am going to stop there, Mr. Chairman. I will be happy to answer any questions this committee may have, or we can proceed with the laboratory directors' testimony, Dr. Wagner's testimony, if he cares to make a statement, and we can have questions at the end, whatever is your preference, Mr. Chairman.

Senator **Warner**. We will take some questions now.

### DEFENSE WASTE PROCESSING FACILITY

Senator **Thurmond**. When do you plan to have a defense waste processing facility at Savannah River in operation?

Mr. **Roser**. Senator, I believe that is about 1990. We are hoping to pursue that vigorously. It is a long-term program but we find nothing barring our proceeding now except adequate funding. We are beginning to get some funding. We think we can use some a little more rapidly, but it is currently programed for 1990, Senator.

Senator **Thurmond**. How much funding are you asking for fiscal year 1983?

Mr. **Roser**. $30 million, Senator.

Senator **Thurmond**. Is this funding level optimal or could the project be speeded up with additional funding?

Mr. **Roser**. In the early stages, this year and next, more money would expedite the program slightly.

Senator **Thurmond**. How much more do you feel could be used usefully?

Mr. **Roser**. We originally requested $75 million so I would estimate we could probably use another $30 million or so this year, Senator Thurmond.

Senator **Thurmond**. Thank you.

## SUPPLEMENTAL REQUEST

Senator **Warner**. Thank you very much, Senator Thurmond.

The supplemental request, have you reexamined the possibility of incorporating this in the fiscal year 1983 budget?

Mr. **Roser**. Mr. Chairman, we have. There are items in there that are time dependent. Principally the items that are time dependent are twofold: One, if we don't get the $15 million that was requested in the research, development, and test program we will probably have to lay off some people at the laboratories and then hope to get them back in fiscal year 1983.

[Deleted.]

So, we feel strongly that we do need that supplemental. Of course, if the supplemental does not get passed, we are looking at all the opportunities to optimize the resources which we will have in 1982 to do the best job that we can.

I discussed that just this morning with all of the managers in the system. I hope that by June we will have that optimization prepared so that in the event no action is taken on the supplemental we will do the best job we can with the money we have.

Senator **Warner**. I will defer to my senior colleagues here, but in my own judgment I think the passage of this supplemental is very problematical. I would ask if you could provide the subcommittee with a good, tight piece of paper on this subject, on its imperative nature.

Mr. **Roser**. I will be very happy to, Mr. Chairman. It is a matter of great concern to us and we will do that.

Senator **Warner**. I will do my very best on this.

[The information follows:]

Senator **Warner**. You have pending a supplemental authorization request for Defense Program. What is the amount of that supplemental authorization request and what programs is it for?

Mr. **Roser**. The fiscal year 1982 supplemental authorization request is for $16.5 million and is required for the following programs:

[In millions of dollars]

| Programs | Authorization | Appropriation |
|---|---|---|
| Research, development and testing | 0 | 15.0 |
| Production and surveillance | 0 | 36.9 |
| Verification and control technology | 2.0 | 2.0 |
| Materials production | 14.5 | 36.5 |
| Defense nuclear waste | 0 | 7.0 |
| Total defense programs | 16.5 | 97.4 |

Senator **Warner**. [Deleted.]
Mr. **Roser**. [Deleted.]
Senator **Warner**. [Deleted.]
Mr. **Roser**. [Deleted.]

Senator **Warner**. What do you think, Senator Jackson, about this supplemental?

Senator **Jackson**. I agree, I think with the ongoing problems with the budget that we are reading about in the newspapers, until that is resolved, Mr. Chairman, I see an impasse, because we don't know what the ceiling is going to be for any of these programs, the overall defense program as well as the nuclear aspects of that defense budget.

Senator WARNER. I opened the proceedings this morning, Senator Jackson, with a personal observation that this particular legislation will be the object of a number—and I don't say this in a disparaging manner—of our colleagues who are deeply concerned about the various freeze proposals. In all likelihood this type of legislation could well be delayed until we have a resolution of those alternatives.

Mr. ROSER. We recognize that very possibility and we are working and will continue to work very hard to do the best job we can with the budget that is available in terms of meeting the most urgent requirements.

Senator WARNER. Any questions, Senator Jackson?

Senator JACKSON. Yes.

### TRITIUM REQUIREMENTS

Mr. Roser, at what point do we run into trouble in meeting our tritium requirements, based on existing capability?

Mr. ROSER. Actually, Senator Jackson, we don't run into trouble in terms of our capability to produce tritium unless we have a failure of an existing reactor. We have or will have four reactors operating at Savannah River and they are capable of the maximum production of tritium and capable of producing plutonium, and we trade those off. [Deleted.] Of course, we operate those reactors on the basis of producing that material which is needed the most at the time. You don't pre-produce tritium because of its decay.

One of the driving reasons for a replacement production reactor is an alternate source for the production of tritium, Senator Jackson, rather than necessarily the need for additional tritium [deleted]. We believe—I believe—very strongly that we should have an alternate source of tritium in an alternate location. [Deleted.]

We are also looking at maximizing a coproduction mode at the N reactor at Richland that will enable us to produce tritium in that reactor should we have to.

We are also looking at the production of tritium in the Department of Energy's various research reactors. [Deleted] but in the long haul we believe strongly that we need an alternate reactor to produce tritium.

Senator JACKSON. I wanted to raise that question because a lot of our colleagues here are not familiar with the fact that tritium has a half life of about 12.5 years and that the stockpile has to constantly be replenished. I run into those who don't serve on this committee saying, "Why do we need to have the reactors?" [Deleted.]

I commend you for addressing this issue so that you have some redundancy built into the supply side.

What is the status on the N reactor on a coproduction basis at Hanford?

### N REACTOR COPRODUCTION

Mr. ROSER. The N reactor has been in a coproduction mode in years past. I think in the 1966–67 time period it was in a coproduction mode; it was not a particularly efficient production mode for either tritium or plutonium.

What we hope to do is research and development that will maximize that coproduction in the event that we need it; but it will produce tritium; it has produced tritium in the past; but it is not as efficient in the production of tritium as are the Savannah River reactors.

Senator JACKSON. But it is a backup?

Mr. ROSER. It is a backup, exactly.

Senator JACKSON. Along the lines you are talking about——

Mr. ROSER. Yes.

Senator JACKSON [continuing]. So that if you run into trouble at Savannah River you will be able to meet the immediate needs, because the tritium in our stockpile must be continually replenished.

Mr. ROSER. That is the reason I showed the chart. [Deleted.]

Senator JACKSON. One other question, Mr. Chairman:

What is the current status of the proposed jumbo reactor, R&D and so on?

Mr. ROSER. I don't recognize the reference.

Senator JACKSON. I call it the jumbo.

## NEW PRODUCTION REACTOR

Mr. ROSER. The replacement production reactor—there was a technical study done, completed about a year ago. Senator, that essentially compiled all the data that are available on the various types of reactors that might be used for a replacement reactor.

The DOE, under my direction, is currently selecting a blue ribbon committee to review that study and to select the best technology, also to review the availability of sites, and to select the best possible site consistent with the choice of the type of reactor; and there are all sorts of combinations that might be put together.

It is my hope and my intention that that committee will make a recommendation to me very early in fiscal year 1983, that I will be in a position to either validate or recommend a change in that to the Secretary of Energy.

Senator JACKSON. What is the date on that?

Mr. ROSER. Very early in fiscal year 1983. It will be, hopefully, by January 1, 1983, Senator. We hope to include in our fiscal year 1984 budget substantial funds for actual design and long lead procurement and so forth in connection with that reactor.

Senator JACKSON. Thank you, Mr. Chairman.

Senator WARNER. Are you convinced that we need to build one or more new replacement reactors?

Mr. ROSER. I am very firmly convinced, Mr. Chairman, that we do need another production reactor. Just briefly, as I mentioned, we should have an alternate source for tritium production. A natural phenomenon, a natural disaster, that would wipe out the Savannah River reactors would put us in a very tenuous position with respect to tritium production.

The Savannah River reactors by the time we can bring on a new reactor will be 40 years old and although they are very dependable and have operated very well, you don't really like to depend on something that is 40 years old when tritium is as vital as it is.

There are many compelling reasons that I am firmly convinced that we do need a replacement production reactor as rapidly as we can bring one on line.

Senator **Jackson**. I have a couple of other questions, Mr. Chairman: As you know, Mr. Roser, section 213 of last year's bill mandated a study of defense nuclear waste. Where does that effort stand at the present time?

### DEFENSE NUCLEAR WASTE

Mr. **Roser**. We are in the process of getting direction from the administration. We have to go back and work with them. We expect very shortly guidance from the Office of Management and Budget, from the White House, directing the Department of Energy to take the responsibility for that study. We are developing the data and they will be available to start being put together as soon as we get the guidance from the White House to do that.

I think there is no question in my mind, Senator Jackson, that we will be able to meet the schedule.

Senator **Jackson**. As provided by section 213?

Mr. **Roser**. Yes, sir.

Senator **Jackson**. But you have not received the guidance from the White House as yet; you are expecting it soon?

Mr. **Roser**. We are working with the White House, telling them essentially what they should tell us, so that we can get on with it.

Senator **Jackson**. You are helping to develop the guidance, hopefully, to yourself, which you will respond to?

Mr. **Roser**. That is correct.

Senator **Jackson**. Well, that is progress. As part of the study will you consider the feasibility—and this is a point, Mr. Chairman, that I think is very important—consider the feasibility and desirability of comingling defense waste with commercial waste in a final repository, or a defense and commercial repository to optimize the use of common facilities?

Mr. **Roser**. That series of questions, that whole subject, will be considered.

Senator **Jackson**. Of comingling?

Mr. **Roser**. You bet.

Senator **Jackson**. How we are going to manage it?

Mr. **Roser**. I think that is an important subject.

Senator **Jackson**. The role of the governors, too, in all of this?

Mr. **Roser**. Just briefly, I think that we are a little ahead of the commercial sector in this regard, but I think it is very necessary that we get on with the business. We will try to cover the waterfront in that report, Senator Jackson, to address those and other issues that are important in making the final decision.

Senator **Jackson**. Thank you very much.

### BUDGET AMENDMENT

Senator **Warner**. Thank you, Senator Jackson.

Let us turn to the subject of the budget amendment. Are we to assume that the figures you have in the charts for 1983 include the amendment?

Mr. **Roser**. They do, Mr. Chairman.

Senator **Warner**. Let us be more specific. How much is that budget amendment and what programs does it support?

Mr. ROSER. The amendment was $316 million, Senator Warner. Principally, it covers many of the programs. The larger amounts are in the weapon programs, $81.7 million including $17.0 million for inertial fusion. Material production is the largest share because that is where we need the most money to get on with it. That is $184 million, with $3 million additional for the waste program.

We have a slight increase in security investigations.

The total for defense programs, which are my responsibility, is $271.4 million and $45 million for naval reactors, making a total of $316.4 million.

Senator WARNER. What was the supplemental number?

Mr. ROSER. We have a supplemental appropriations request of $97.4. Senator. Of that amount, $52 million was for weapons, about $37 million for materials production. Those are the principal items. There was about $7 million in there for defense waste as well, but it totaled $97.4 million.

Senator WARNER. I had the pleasure of visiting the laboratories. I repeatedly heard that the total was in the area of half a billion dollars or somewhat less. I judge that has been reduced now?

Mr. ROSER. There were a couple of items that we did not get full support on, [deleted]. There were a couple of other things that we had hoped to get in. One was some funding to proceed more rapidly with the replacement production reactor but, of course, as is necessary, once the Office of Management and Budget reviewed our request in the overall context of what the President's program is, they came out with a little bit different numbers than we asked for, [deleted].

### STOCKPILE

Senator WARNER. Turning to the weapon stockpile size, what is the latest information on the size of the U.S. nuclear stockpile versus that of the Soviet Union?

Mr. ROSER. Dr. Wagner has some good information on that. Do you happen to have a graph?

Senator WARNER. Is this an appropriate time to get into that subject?

Mr. ROSER. I think it probably is.

## STATEMENT OF RICHARD L. WAGNER, PH. D., ASSISTANT TO THE SECRETARY OF DEFENSE (ATOMIC ENERGY)

Dr. WAGNER. Let me show this one chart [chart deleted], which takes the stockpile from the very beginning out to the end of the extended planning period in the nuclear stockpile memorandum.

As you know, this year's stockpile memo, for the first time, has put a long planning period in, so we go out to 1997. You can see the development that Mr. Roser referred to earlier, building up to the peak around 1960 as far as the number produced, and the peak of the number in the stockpile, [deleted].

Since that time the stockpile has declined a little bit. We predict and expect that it will go up again slightly during the period that the stockpile memorandum actually authorizes the buildup, which is through 1987, [deleted]. The reasons, of course, for retirement are that new systems come in which require new warheads and in some cases also the warheads themselves, simply because of their own characteristics, become obsolete and need to be retired. The bulk of the stockpile that we have today was built back in the early sixties, so by 1987 or so that portion of the stockpile will be 25 years old.

[Deleted.]

Senator **Warner.** What is the total yield? Was 1960 the peak?

Dr. **Wagner.** 1967 was the peak year for numbers of warheads; the total yield peaked in 1960. [Deleted.] This chart out through today, 1982, is available in an unclassified form without the numbers, just the shape of the curve, showing that there is a peak in 1967 and then declining as a proportion.

Senator **Warner.** What do you think about the declassification?

Dr. **Wagner.** I would be hesitant to declassify the actual totals stated in precise numbers.

Senator **Warner.** You mean category of weapons?

Dr. **Wagner.** I would be a little more hesitant to declassify the totals in terms of categories. I would want to think very carefully about what the Soviets would do with the knowledge of how many weapons we have certainly by category. I must say I have not thought that through.

Senator **Warner.** I share your concern, but we are in the fray now.

[Deleted.]

Dr. **Wagner.** Senator, let us take to heart your suggestion to think through what we can declassify. We simply have not thought through yet what benefits the Soviets could derive from knowing these numbers.

I would not want us to respond to the public debate needs at this present time in a way that would give the Soviets a piece of knowledge that they might not otherwise have which they could use to their benefit for years and years.

[Deleted.]

The reason for that is, in the early fifties and sixties our systems simply were not very accurate and the continuing trend for the last 20 years has been improved accuracy, not just for the missiles but also for the bombers.

Senator **Jackson.** If you have a bomber cutback, that is your heavy yield?

Dr. **Wagner.** Yes.

Senator **Jackson.** And your Titan?

Dr. **Wagner.** Yes.

Senator **Jackson.** And before that were various liquid fueled Atlases, Titans, and whatever?

Dr. **Wagner.** Polaris and early Minutemen.

Senator **Jackson.** With accuracy improving, the yield per unit or per warhead goes down?

Dr. **Wagner.** That is right.

Senator **Warner.** Doesn't flatten out?

Dr. **Wagner.** It will stay about flat.

Senator **Jackson.** Yes, but from the peak.

Dr. **Wagner.** The reason it stays flat, incidentally, is because even though the next generation will have better accuracy, the Soviet target base is getting harder. It is not just silos; it is a lot of different kinds of military targets.

Senator **Jackson**. Command and control they are hardening?

Dr. **Wagner**. Yes, sir.

Senator **Warner**. You asked also about the Soviet stockpile numbers?

Before we leave this, let us have some hard scrutiny on whether or not we can declassify this chart.

Dr. **Wagner**. I feel better about declassifying this one than I do about the total numbers.

Senator **Warner**. I want you to have an opportunity to talk with your colleagues and weigh this very carefully. I am not holding you today to a decision. I am trying to impress on you, as is Senator Jackson, the tough job that we have here in the Senate and in the public domain, and this type of chart will help us.

Mr. **Roser**. This has been a matter of concern to us over the past several weeks, Senator Warner.

Senator **Warner**. You are in a time sensitive mode, as are we.

Mr. **Roser**. Yes, sir.

### SIZE OF THE SOVIET STOCKPILE

Senator **Jackson**. I think the chairman has raised the proper question here. When the matter comes out on the floor, one consideration which is outside of your immediate area, Mr. Chairman, is the challenge to the Soviets to make available, and through some third party check the accuracy of, the numbers that they have, and yields, as the first step toward arms control, arms elimination, arms reduction, because you need to know forthrightly what you are talking about.

We have our own estimates, but even those are estimates, which I assume you will get to in a moment; but I think it is going to move inevitably into the negotiating sector and you certainly will have to start, Mr. Chairman, from certain assumptions. [Deleted].

### SOVIET PRODUCTION CAPABILITIES

Senator **Warner**. The Senator raises a most important point. The American public still will have a measure of skepticism when we use these charts and diagrams. If we can say that the United States has this many factories and the Soviets have that many factories, then it begins to translate into more understandable rhetoric.

What can we put out in the public domain for a comparison between the production base of the United States and a production base of the Soviet Union?

Mr. **Roser**. That is something we are going to have to look at, Senator Warner. Offhand, I think most people know that we have three or four operating reactors in this country. We will have five when we get the one restarted at Savannah River. [Deleted].

Senator **Warner**. In the next 2 weeks Senator Jackson and I have to testify before the Foreign Relations Committee, which could well be a celebrated hearing. I would like to put up a chart which says "Here is the number of factories we have and here is the number of factories they have." It is a dramatization that begins to win the public to your point of view.

Senator **Jackson**. I think what would be wise, Mr. Chairman, would be to challenge the Soviets: "Here is what we are willing to do." I question whether we at this point in time ought to give out—I think I agree with Mr. Wagner—the specific details, because I am not quite sure how they could take advantage of it; but if there could be an arrangement, Mr. Chairman, by which we make clear our willingness to spell out the numbers, because if you are going to enter into an agreement to eliminate, you have to know what you are eliminating, and that gets into some tricky questions about onsite inspection.

Clearly, there is a difference between monitoring an arms control agreement and monitoring an arms elimination agreement. It is totally different. Again, this is not understood.

In the latter, very clearly we are going to have to have onsite inspection to determine what weapons have been eliminated. I mean the plutonium, how are you going to dispose of it and seal it off? It is entirely different than the former, where you can rely on national technical means.

Do you all agree with that?

Dr. **Wagner**. Yes.

Senator **Jackson**. They are totally different. With the former you can use national technical means. With the latter you get right down to, you know, let us face it; and that is onsite inspection.

These things need to be flushed out and tossed on the table, along with my proposal to have a postcommunications center to deal with the danger of war by accident and miscalculation. That is what the people of this country are worried about.

With just a freeze, you know, the terror is still there, only it is in frozen form. I don't know what the difference is. You can thaw it out pretty fast sometimes.

Senator **Warner**. Senator Thurmond, do you have some observations?

Senator **Thurmond**. I don't think I have anything further, Mr. Chairman. I am very much impressed with their testimony. [Deleted.] That is all I have.

Senator **Warner**. You have been very forthright.

I just want to bring to your attention that you gentlemen come to this committee to testify each year; you do your job and then it is up to a handful of us to take these things to the Senate floor. I have been in 3 years of these battles. I think the biggest one that we have ever had is coming up. Senator Jackson and I have 60 Members of the Senate cosponsoring our freeze proposal. I am reasonably confident that that is going to represent the framework of the thinking of the U.S. Senate. Although it will be going through the Foreign Relations Committee and I don't know how it might be amended there, but basically the sentiments of some 67 are good. We might come down with a bone-crushing cut in the defense budget and everyone is going to think that we are on the threshold of new talks on SALT and why spend all this money.

I appreciate your problem of stop, start and hiring, and you can't put your laboratory system back together again in 6 months. We have to keep your substructure intact.

Balancing the battle we have here against the need we have to continue to live in this high degree of classification, I think we have had three decades of relatively quiet support in the Congress of the United States, and we have been able to get these things through.

Senator Thurmond, you have been here a lot longer than I. Do you have the same apprehension that I have?

Senator **THURMOND**. Yes, I do.

Senator **WARNER**. You have gone to the floor more times than most of us and put your shoulder to the wheel to get some of these budget items through.

Mr. **ROSER**. We recognize your concern, Mr. Chairman. I think Dr. Wagner and I both will work very hard to try to strengthen your hand to the greatest extent possible.

With your permission, Mr. Chairman, I would like to call on our lab directors for some brief statements. They may have some thoughts along these lines as well.

Senator **WARNER**. I like the independence among your lab directors. It is a good competitive spirit. Let us see what they can provide us.

Mr. **ROSER**. I am going to ask them to come up. We usually do this in alphabetical order. I think we will probably reverse the order. Since the Sandia Laboratory usually comes last, we will ask him to go first and put Dr. Kerr in the middle and wind up with Dr. Batzel.

Senator **WARNER**. I want to thank you for the courtesies you extended me during my visits to your areas.

## STATEMENT OF GEORGE C. DACEY, PH. D., PRESIDENT, SANDIA NATIONAL LABORATORIES

Dr. **DACEY**. Thank you very much, Senator Warner. I will try to be brief.

Senator **WARNER**. I would not worry about being brief.

Dr. **DACEY**. I know this is not news to you, Senator Warner, but I think it would be worth repeating for the other Senators and for the record, the kind of perspective I gave you when you visited us recently at Sandia.

As you know, I am returned to Sandia after an absence of about 20 years. I was there in the sixties and I am back again. I have noticed a number of changes. I think it would be worth putting those on the record for what they are worth.

In the first place, I think there is a lot of good news. I would like to start out with the good news.

I have noticed that the technical strength of Sandia is at an all-time high. There are a number of indicators of that. One is the degree of training of our staff, which has changed dramatically over the past 20 years. Where we were about 25 percent advanced degree in the early sixties, we are now 75 percent Ph. D. and master degrees. That means, I think, that the degree of sophistication of the staff has increased and matches the technical improvements that have occurred over that period. That is a piece of good news.

Today our technical capabilities are at an all-time high.

Today we are able to put in modern weapons hardened solid-state devices such as microprocessors—sophisticated, modern electronics equipment—whereas earlier weapons tended to be much more mechanical. Electronics technology is coming of age as far as the nuclear weapons are concerned and I think that possibilities for future sophistication are even greater.

Therefore, on at least two counts we have some very good news: The staff is more highly trained and they are deeply into a very modern piece of technology.

In addition, there is a trend—you saw some of it in Mr. Roser's testimony—toward the use of modern technology in design itself, computer aids to design, computer aids manufacture; such as the numerically controlled machine that he showed. So there is good news on the design front.

Another piece of good news, I think, is that we managed very well—and I can brag about that since I personally did not have anything to do with this—in the transition from all weapons work to include other kinds of work—such as the program at Sandia.

The programs that were chosen were, I think, synergistic with the capabilities of the weapons programs and that served to preserve for the country a very strong multidisciplinary engineering team.

Now I would like to turn to the bad news.

The bad news stems from the fact that in the switch back from energy programs to weapon programs, which is now occurring, we haven't quite balanced the pendulum as much as we perhaps could have done. Let me give you a couple of numbers:

During the period from fiscal 1970 to fiscal 1981, the number of people at Sandia on weapon programs decreased from 6.850 to 4.438. That is a 35-percent decrease. The level of R&D has gone so low that we are increasing the risk of schedule slips on weapons development programs and we have not put out new ideas at the same rate that we were doing previously in the weapons program.

It is true, many of the people we lost from the weapons program went to work on the energy programs. The energy work is decreasing; it is going down to 50 percent less in fiscal 1983 than fiscal 1981. It will go down from about 23 percent of our effort to about 12 percent of our effort.

While there has been an increase in the weapon program, it has not been a corresponding increase; therefore, the total numbers of people at Sandia will be going down over that period.

Now, at the same time that those total numbers are going down, the load of weapon requirements is going up. That is why I am concerned about the technical risk which we may be running in the future in undertaking a larger weapons program with a smaller staff and with old and aging facilities that have not yet been replaced.

I finally would like to say that looking ahead to the future, I want to project an air of optimism. I believe that the three weapon laboratories—Sandia in particular—are in extremely good technical shape. The multiprogram laboratory basis on which these facilities are run, I think, is a very important thing for the country to recognize and to continue.

There is a good technical symbiosis. An example is how we have been able to proceed from accelerators to inertial confinement fusion, to special isotope separation with the same skills as national priorities changed.

I think we will need to continue to modernize the stockpile, whether or not there is a freeze.

Senator **Warner**. Whether or not there is a freeze—as I interpret that freeze, it is to stop everything and fire everybody. There are many interpretations going around. The folks who have put freeze proposals forward have not thought it through. I asked one person, "Does that mean you are suggesting to fire everybody?" He moved sidewise around the microphone. The American public interprets "freeze" as we stop, you go to the table, Mr. President, and come back home with the "bacon" and we will live happily after and build houses and drive new cars and so forth.

Dr. **Dacey**. Let me give you a personal opinion.

Senator **Warner**. Yes. I am going to dwell on this freeze considerably, later, if you want to wait until that time.

Dr. **Dacey**. I think my answer is a very simple one: If by freeze you mean that you are going to try to limit in some sense the total amount of nuclear materials which could explode and produce fallout or kill people, that is one definition. You can always define a situation in such a way as to make it sound like a good thing. However, if you mean by "freeze" that you intend to stop thinking, to stop considering what the weapon possibilities are, what modern warfare can, in fact, become, then I think you are taking a dangerous risk with this country's security.

There is no way, it seems to me, that you can inspect the way in which human minds are thinking ahead. If we were to stop research and development leading to the knowledge of what the technical possibilities are for the future, I think we would be taking a most dangerous sort of risk. I could not interpret "freeze" to mean that in any sensible way.

That is really all I had to say. It is simply that our technical world is in good stead right now; it does have capacity problems; it is not large enough; it is aging and needs some improvement, but from a technical standpoint I think there are enormous possibilities for improvement ahead. We do need to make it clear that such progress is in the public interest and that we should charge on at full speed.

Senator **Warner**. Thank you very much.

## STATEMENT OF DONALD M. KERR, JR., PH. D., DIRECTOR, LOS ALAMOS NATIONAL LABORATORY

Dr. **Kerr**. Mr. Chairman, I appreciate the opportunity to appear before this committee again.

With your permission, I would like to use a few charts to illustrate several points I would like to make today.

Senator **Warner**. Please proceed.

[Chart presentation.]

Dr. **Kerr**. You may recall last year when we appeared before you——

Senator **Warner**. The chairman is impressed with the economy of the chart presentation. You don't have anybody here to run the machine. You are running the machine yourself.

Dr. **Kerr**. Thank you, sir.

Senator Warner. When the Department of Defense comes up they have a machine operator; they have a fellow to hold the thing; they have a fellow to pack the thing; one electrician is brought along; a lighting expert is brought along.

No disrespect, gentlemen.

General Hoover. I am with these guys.

Senator Warner. On this tour of duty, yes. [Laughter.]

[Deleted.]

Dr. Kerr. It really has to do with how weapons enter the stockpile in the future. If their yields are above the threshold, they will enter on a different basis than those in the past that were tested full yield. I only pose this as a caution; it may in fact lead back to your concern about nuclear freeze or other restraints on development.

This is one where we have some current experience and we begin to see the cost, technically, economically, and operationally as we contemplate new weapon systems.

In other areas that you have authorized, such as inertial fusion, we have had the opportunity to show you some of the facilities, to talk with you about some of the results. All I want to do is remind you that your support not only has built the facilities but also in the case of our system Helios [chart deleted] we have done some 850 experiments during the past year since we talked to you last. In doing those experiments, we have learned a great deal about whether gas lasers, particularly our $CO_2$ design, have any use for weapons physics or for the initiation of fusion reactions in the laboratory.

We have managed to rule out certain classes of targets. We have managed to get some ideas of our fundamental understanding of the physics of interaction as to how to proceed in the future.

In terms of the future, we are moving forward on the construction of the Antares laser system [chart deleted] which is roughly a factor of four or five more powerful than the existing one. That we intend to finish in a year and a half. It is a construction project that you have authorized.

We have now operated one of the electron guns some 1,700 times, so we believe that questions of reliability have been answered and we could scale up with some confidence. We are proceeding with the construction as planned.

### MULTIPROGRAM CAPABILITIES

I talked about weapons briefly, and about laser fusion. One of the things I want to convey is that the national laboratories aren't specialized. In fact, they are multiprogram, as you observed when you visited us. It is important to us, as institutions, that we do work not just in nuclear weapons, not just in inertial fusion. [Deleted.]

The last point I would like to make in terms of the laboratory is to strongly support the continuing efforts by the Department of Energy to seek funds to refurbish and replace older facilities.

At the risk of seeming somewhat mauldin, I would just want to illustrate a couple of these facilities that we are going to be approaching you and the Department of Energy on in the next few years.

### MATERIALS PHYSICS FACILITY

A facility, for example, built back in 1953, is a materials physics facility. [Chart deleted.] We use it, for example, in the study of properties of materials at high pressure. It is these sorts of facilities that have given us the essential information for the weapon programs that are being discussed when we talk about refurbishing.

When you came to visit us, as always we wanted to show the newest, the most exciting and perhaps the best looking, so we avoid taking you off to see something like this, but it is an important thing that we continue to try to rehabilitate those parts of our facilities most important for the current programs.

Senator WARNER. You have to take a lesson from the military. The first time you visit them you go through and work your way back.

Dr. KERR. Well, sir, we invite you back, but I don't think we will organize the business quite that way.

### MATERIALS RESPONSE FACILITY

This is a similar one built in 1948. [Chart deleted.] Roger will wince a bit when I remind you there was not even a second laboratory then. We are still using the facility that was built at that time. You can see dimly in the background one of the most essential members of our staff, in fact. You will notice that we have a fine looking black and white cat. You might ask why is that cat on the taxpayers' payroll. Well, for a very important reason: The facility is old. During parts of the year the mice that live in there are attractive meals for rattlesnakes; so some of our explosive technicians have been surprised by rattlesnakes. We have gone to the heart of the problem and we have hired the cat to take care of the mice.

### INTERNATIONAL SECURITY AND ARMS CONTROL

To finish up my remarks, something that we and Livermore participated in took place a few weeks ago in Los Angeles. The University of California, which has, of course, always operated our two design laboratories, sponsored a conference on international security and arms control. In fact, Dr. Batzel and I were part of the organizing committee. Perhaps for its intellectual content it wasn't the most remarkable conference. As you are well aware in the discussions we had with you during your visit, most of the ideas for arms control are relatively old and have been worked over many times.

Important on this occasion was the fact that for the first time in recent years, members of the laboratory staff involved with weapons were meeting their colleagues from the campuses with all of the concerns they have that you hear about from the public today.

There were discussions of the nuclear freeze; there were discussions of potential arms control at the theater level. I think it was a very useful start.

Senator WARNER. I concur. Did you write up papers on this subject?

Dr. KERR. Yes, sir, we did.

Senator WARNER. I am going to ask you to provide us with copies of those.

Dr. **Kerr.** I will be happy to do that. I think one of the important points, however, is that those of us involved in the weapons programs and the many who have been in it longer than I, have been working in the main in support of that very difficult to articulate concept of deterrance, the idea that we are trying to prevent nuclear war by deterring an enemy, a potential adversary, through the threat of punishment. It is a very difficult concept to explain.

At this conference, in trying to explain it at dinner one night, I was confronted with the question you are now facing. Barbara Tuchman, an historian, gave one of the speeches. At dinner that night after I explained to her we were trying to prevent war, we were trying to arm in ways that were credible so that the adversary would not consider using his weapons, she looked at me and said, "But why do you need as many as you have? What is the possible rationale for those numbers?"

I launched into an explanation and lost her totally—which, again, is the problem you face. I tried to explain the concept of the Triad, the concept of redundancy, common failure mode, tactical weapons that have to spread across the front.

She said, "Nonsense; it doesn't add up."

I think that is the issue where we in the laboratories, with the help of DOE, can perhaps do more to help you; but in the end it is a political question, political leadership that we need in order to help push this through. We technical people can argue with facts, we can help you with concepts, but the integration and discussion with the voters, I think, is a very difficult job where we can only help.

Senator **Warner.** It is so interesting that she is one of my favorite authors and by sheer coincidence I pulled down the book, "Nuke Power," that she wrote, to look at something. She is a very convincing, highly-accomplished individual.

It is the Barbara Tuchmans that you are going to have to persuade in a calm, unemotional way. You with your background and knowledge, I am convinced, do have an appreciation of the magnitude of the job that we have to deal with.

I would like to look at a side-by-side comparison of the discussion.

Dr. **Kerr.** I will be happy to do that.

In view of the fact that others are waiting to testify, I will send you a copy of my paper.

Senator **Warner.** Maybe you have a copy of her speech on tape.

Dr. **Kerr.** We do.

Senator **Warner.** I have to study these things. My job is public relations. I will be one of the ones in the forefront here trying to present our case.

Dr. **Kerr.** I will give it to you.

Senator **Warner.** I would appreciate that very much.

[The information follows:]

## PROSPECTS FOR THEATER NUCLEAR FORCES

STATEMENT BY DONALD M. KERR, DIRECTOR, LOS ALAMOS NATIONAL LABORATORY, UNIVERSITY OF CALIFORNIA

Rethinking strategic and theater nuclear policy is imperative given the deteriorating NATO Alliance and the ever-increasing Soviet military threat. Following World War II, the Warsaw Pact had far larger conventional forces than NATO in Europe; but the United States had nuclear weapons and the Soviet Union did not. Soviet forces sustained communist regimes across Eastern and Central Europe. The Soviets also tried to force the Western powers to abandon Berlin. Here, the West stood firm showing that Soviet attempts to apply pressure through its military presence could be resisted by a strong and determined Western alliance.

Since then the military balance has changed radically. The Soviet Union has increased its advantages in conventional forces in Europe, having placed greatest stress on offensive weapons such as tanks and mobile artillery; recently the Soviet Union has also acquired force-projection capabilities with a worldwide navy. Most significantly, the Soviet Union has now matched the United States in intercontinental strategic nuclear forces and has achieved clear superiority in long-range theater nuclear forces and in chemical warfare capabilities. At the same time the Soviet Union has matched the West with the technical sophistication of its weapons.

In both the United States and Western Europe, the environment for the making of nuclear weapons strategy has been undergoing important changes. The Western Alliance's deterrent posture must insure that the Soviet Union cannot deprive the alliance of all alternatives save surrender. Successful deterrence requires that, in the mind of a potential adversary, you have blocked the full spectrum of potentially decisive moves. Despite general agreement on the need for such deterrence, an intense debate has arisen in the last decade within the Western defense and foreign policy community over several issues—the prospects and constraints on the strategy of extended deterrence for Europe, the implications of the Soviet military build-up, and the appropriate responses to increasing manifestations of Soviet global power.

Both in the United States and Europe, important policy divisions over the nature of and requirements for an effective nuclear strategy, the merits and features of arms control, and the intentions and capabilities of the Soviet Union have spilled over into the public arena. The 1976 Republican presidential primaries with their bitter criticism of detente, the public furore over the SALT II treaty, President Carter's announcement of PD–59 within the context of the 1980 presidential campaign, and the rhetoric of candidate Reagan, then President Reagan, marked important stages in the public debate and in the process of informing the American public about the nuclear defense issue.

Today, President Reagan seeks to fortify America's defensive posture to bolster his new foreign policy. His efforts to convince the Soviet Union of Western power and determination are a translation into policy of his mandate, the electoral outcome of the prolonged, sometimes bitter policy debate. The resulting rhetoric of and supposed preparation for a nuclear war fighting strategy is entering public consciousness and is provoking some protests. In the context of substantial public support for a hardline foreign policy, the possible emergence of a large new peace movement focused on an increasing threat of nuclear war merits attention.

In the policy debate, it is not always remembered that a substantial part of U.S. nuclear targeting is and has long been directed at Soviet military installations. This practice, supposedly the definitive feature of a war fighting strategy, has been part of US deterrence strategy. That strategy combines a base of mutual assured destruction with limited warfighting capabilities in the form of "limited strategic options" or "countervailing options." Opinion polls indicate, however, that most Americans believe that any war with the Soviet Union implies more or less direct resort to all-out nuclear war. Hence, there is a sharp contrast between past and evolving U.S. policy, and public consciousness of what that policy is. The new Reagan policy with its emphasis on civil defense preparedness, war mobilization, and emergency planning, apparently has increased public anxieties. In this way, rhetoric and action intended to convince the adversary of our resolve and determination in order to prevent nuclear war, may increase public concern that nuclear war will occur. In a democracy, this contradiction could have important consequences for a mandate which even conservatives warn may not be sustainable over the long run because of budgetary constraints on all spending, and because of the cyclical nature of popular support for high defense spending.

Lastly, special emphasis should be placed on the leadership role of newly mobilized sectors of the clergy, scientists, and physicians. Public acceptance of the increased emphasis on defense preparedness may be drastically affected by their views. The talk of nuclear war fighting seems to have mobilized professionals whose work in medicine, religion, or science combined with moral beliefs lead them to question the validity of war fighting assumptions. These groups have at their disposal powerful organizational resources. They are also well situated to affect public consciousness, the physicians because of their unique status in society, and the clergy because of the moral perspective from which they question the policy.

George F. Will recently[1] suggested that "a coherent position, consistent with traditional church teaching, can turn on the distinction between what is tolerated and what is approved. Instruments of mans destruction, which for reasons of accuracy or controllability cannot be or are not apt to be used in ways that discriminate between military and civilian targets, cannot be approved. But they can be tolerated if the unilateral renunciation of them would bring on an intolerable evil (such as subjugation to an evil regime), and if the nation strives to reduce and end reliance on them."

In the coming months as nuclear issues appear on state referendums and some political leaders raise the issue in the context of political campaigns, public concern about nuclear war could erode support for the President's foreign policy. The outcome will depend on whether concern about nuclear war fighting can be defused by lowering the visibility of the policy, or by convincing people that the policy will deter war. It will also depend on whether arms control can be sustained on terms acceptable to a conservative administration and the broader public.

## STRATEGIC CONTEXT

In the face of this growing concern and criticism, there has been considerable uncertainty about the substance of the Reagan Administraion's strategic policy. Campaign speeches and transition team ideas indicated that the Administration might strive to re-establish strategic superiority or to try to develop a war-fighting posture designed to limit damage through a strenghened counterforce—or defensive—capability. Discussions of large offensive force additions, especially increasingly accurate missiles capable of destroying hardened targets, Ballistic missile defense, and civil defense all contributed to the view that the Reagan Administration would react strongly, if not over-react, to the perceived Soviet threat—the so-called "window of vulnerability".

The United States has not had a real nuclear strategy since the early 1960s. Instead it has relieved on rhetoric at the political level, targeting plans at the military level, and on an awkward patchwork of technology, individual weapons program, and various command and control systems, with the hope that nuclear weapons would never have to be used in practice. Each of the major elements that shapes U.S. nuclear strategy has tended to be decoupled from the others. Civilian strategy documents like NSDM-242 and the recent Presidential Directive 59 (1980), explicitly outlining a new strategic nuclear doctrine, have never been properly translated into targeting plans, force plans, and command and control capabilities. Theater and strategic nuclear doctrine remain largely decoupled despite the growing overlap in military capabilities. Weapons system issues have been debated on cost and political grounds while the Triad concept, although providing a necessary variety of capabilities and failure modes, has also allowed advocates of bombers, ICBMs, cruise missiles, and SLBMs to pursue their separate paths. Strategy has largely been ignored and targeting has dealt with the result as it arrived.

Nevertheless, the fundamental objective of U.S. strategic nuclear policy has long been the deterrence or containment of any conflict that might escalate to nuclear war. Though this objective has endured, the evolving character of both U.S. and Soviet force structures and changing assumptions about the strategic environment have resulted in numerous revisions to the way we have planned to implement our objective.

During the period of "assured ascendancy" under Eisenhower and Dulles, characterized by our quantitative and qualitative superiority in nuclear forces, we pronounced the doctrine of "massive retaliation," that is, that any act of aggression against our vital interests, including allies, would be countered with a crushing nuclear response. As Soviet capabilities increased and the credibility of massive retaliation eroded, we pursued a strategy of "flexible response," or, meeting aggression at an appropriate level or place with the option of escalating the level of conflict if deemed necessary.

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[1] Newsweek, 21 December 1981, p. 94.

Under the Kennedy Administration, McNamara flirted briefly with a counterforce doctrine for use of U.S. strategic forces, but quickly reverted to "assured destruction." Assured destruction eventually became "mutual assured destruction" (MAD) as it became apparent that both the Soviet Union and the U.S. had the capability to inflict unacceptably high levels of damage in a punitive second strike.

Later, questions arose about what MAD could in fact deter—was it adequate for providing extended deterrence for Europe, and for deterring limited Soviet strategic strikes against the United States? Under President Nixon the Schlesinger Doctrine of "Limited Strategic Options" was developed to fill the perceived gap in deterrence. This was followed and elaborated in the "countervailing strategy" of President Carter's PD-59.

### REAGAN'S STRATEGIC PROGRAM

Many of the uncertainties which led to these policy changes remain. The Reagan Administration's primary response to date, its decisions on the modernization of U.S. strategic forces, has done little to resolve uncertainties about U.S. strategic policy directions. Neither the absence of clarity about our strategy, nor the concerns of public critics, have been lain to rest.

One interpretation of the Reagan plan is that since a large proportion of our ICBM force will not survive in the face of a Soviet attack, the U.S. is seeking to develop a first-strike capability and strategy. This view was articulated by Herbert Scoville, Jr. in his recent article "First Strike". Other strategic experts believe that the Reagan MX basing plan will move the U.S. toward a launch-on-warning strategy to insure survival of its ICBM force.

According to a third view, a launch-on-warning policy is probably politically impossible, although perhaps an effective deterrent as a declaratory policy. In reality, in this view, the U.S. will shift exclusively to a soft-target strategy for its retaliatory strikes (unless and until the new Trident D-5 missile demonstrates reliable hard-target capability). This, in turn, would mean a more explicit assured destruction doctrine, even though this is not at present the new Administration's position.

Yet another view implies that the recent decisions represent the first step in a process which will lead to ballistic missile defense: deep, super-hardened silos; an airmobile MX such as the Big Bird; etc. These would reduce the vulnerability of our more accurate, hard-target capable systems and allow for a more diversified strategic policy, capable of addressing damage-limiting or countervailing targeting. The Administration may eventually choose the last option, but this has not been made clear and hence the confusion in this country and abroad.

Whatever the strategy turns out to be, it is clear that the Reagan modernization program is compatible with arms control. An on-going program will provide the U.S. with leverage in strategic arms limitation or reduction talks. The Reagan Administration has affirmed its commitment to arms control, albeit with an important caveat, in recent testimony [2] by ACDA Director Eugene V. Rostow. Noting that the SALT I agreements and the process of negotiating SALT II did not prevent the extraordinary buildup of the Soviet nuclear arsenal, Rostow made the following point:

"Euprodic enthusiasm for arms control is indeed a dangerous drug, an escape from reality. But in the foreboding context of Soviet-American relations, the arguments for a major arms control effort outweigh the arguments against. The Soviet-American relationship is now so tense that if we are to be true to ourselves we must seize every opportunity to negotiate for peace, however adverse the odds may be. Under present circumstances, arms control ought to be a useful catalyst for a movement towards peace, if we discipline ourselves to view arms control as an integral part of our foreign and defense policy but not a magical substitute for it. The Soviet rush for power has accelerated rapidly during the last ten years, fueled by a fantastic long-term program of arms accumulation. The Soviet program has naturally aroused resistance among those who wish to remain free. The result is a world crisis for which the only rational and humane solution is Soviet-American cooperation to establish peace. The rational place for such cooperation to begin is in the field of arms control, arms reduction, and disarmament.

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[2] Hearing of the Subcommittee on Procurement and Military Nuclear Systems of the House Armed Services Committee, Nov. 16, 1981.

### IMPLICATIONS FOR THE EUROPEAN THEATER

The serious condition of America's strategic policy is evident in our NATO defense dilemma. None of the strategic policies described previously, with the exception of a first-strike, is credible in providing "extended deterrence" to the NATO theater. The U.S. appears unlikely to return to the strategic superiority and war-winning capabilities of the 1950s and early 1960s. This would seem to shift a heavier burden of European deterrence and defense onto NATO nonstrategic forces.

There is little question that this burden of deterrence must be shared among the allies, but our forces in Europe are not at this time capable of implementing current NATO defense strategy.

The Reagan Administration has attempted to highlight the immediate problem involved in deciding on appropriate weapons systems and strategies for NATO. In September the Administration issued a pamphlet called "Soviet Military Power" which detailed the Soviet advances both in strategic and tactical weapons. Backfire, the SS–20, and the new series of tactical surface-to-surface missiles, the SS–21, –22, and –23, are all on the menu of nuclear forces that NATO may confront.

Yet at this time, when a major effort is needed to revitalize NATO defense, the alliance is under severe strain on a wide spectrum of issues unrelated to weapons strategy. These involve economic relations with the East, the North-South dialogue, and conflicting approaches to regional conflicts such as those in the Middle East and Latin America. Several allied nations are governed by fragile coalitions, under challenge for an array of social, economic and political reasons. Given this backdrop, the constraints on rejuvenating NATO's defense posture are very real. As evidenced by the anti-nuclear demonstrations in the Netherlands, Germany, Britain, Italy, and elsewhere, the peoples of Western Europe—and increasingly Western European nations—are more and more worried about becoming a nuclear battlefield, and balk at nuclear policies and force structures that appear to make a nuclear war confined to Europe more feasible.

The current focus of the European debate, the deployment of long-range theater forces, contrasts the two general approaches to European defense. One calls for fighting and winning on the (European) battlefield. The other calls for early escalation to U.S. strategic nuclear forces as the main element of deterrence. Deploying new, long-range nuclear systems does not resolve the differences between these approaches, and in fact calls them to the fore. Hardwere alterations simply cannot replace a common strategy for weapons employment.

The 1979 decision to modernize NATO's theater nuclear forces by deploying 108 Pershing II missiles and 464 ground-launched cruise missiles was primarily a response to the perceptions of a growing Soviet threat, and was viewed by many Europeans as strengthing the "linkage" between Europe and the U.S. strategic nuclear force; later, it came under fire from Europeans for being "docoupling." This was also a dual track from the outset, with a decision both to deploy and to negotiate. The delay of the Reagan Administration to embrace any arms control negotiations undoubtedly exacerbated European perceptions of American intentions. Many of the countries involved also experience the uncertainties, frustrations, and fears associated with losing control of one's own defense, of too closely linking their national security to the policies of a global power whose geopolitical interests diverge and whose style of foreign policy emphasizes domestic concerns.

If the commitment to European arms control is to represent more than a cosmetic response, and if the U.S. is to link it to its other arms control plans, a great deal of planning must be done to identify the acceptable outcome of the negotiations. Two principles should guide us. The fundamental one is that arms control must enhance security. This means that it must limit the forces of both East and West. Second, an arms control treaty must be properly verified, so that confidence is created by each party knowing that others are complying.

The problem of verification is especially thorny for intermediate and short range nuclear systems. Of these, the single-purpose (i.e. nuclear-only) long range missiles are the easiest to address. If a missile is located, it must be assumed to be a nuclear system. However, since the introduction of mobile launchers, and the relative ease of hiding or camouflaging them, limiting to a certain number of such systems would be unverifiable. The best option from a verification point of view would be the "zero-option." Thus any missile of that type discovered would represent a violation of the treaty. The difficulties and risks attendant on hiding prohibited missiles would probably outweigh the benefits, and the parties to the agreement would most likely opt for different systems to meet their targeting needs.

For dual-capable (i.e. nuclear and conventional—or even triple-capable, including chemical) delivery systems, almost no verification scheme is imaginable, short of free-wheeling on-site inspection of the delivery systems and of warhead stockpiles. In terms of a verifiable arms control agreement, the long range, single-purpose missiles appear to be suitable candidates, but agreements short of an outright ban would pose severe verification problems. For the shorter range, dual capable systems, only the possibility of adopting a strategy which minimizes the need for such systems appears to present any prospect for important reductions. Such policies would stem more from national defense policy considerations than from arms control negotiations.

We further require a strategy that can weave together the needs of U.S. national security and NATO defense in a way that is politically feasible for Europe and economically reasonable for the United States. Such a strategy cannot seek narrow solutions by isolating theater nuclear forces from our overall strategic planning. Like the structural problem confronted by the architect of a Gothic cathedral, the enormous span of U.S. security interests requires resilient, flexible and extended forces to deal with the broad spectrum of potential conflicts. Ideally, this force structure should be relatively insensitive to the further buildup of Soviet forces and modest technological change. The price to be paid may be lowering the already fragile barrier between a nuclear war confined to Europe and overall strategic conflict.

## A COMPREHENSIVE FORCE STRUCTURE PROPOSAL

A coordinated theater and strategic force posture is needed for both deterrence and conflict resolution. It is proposed that ICBMs serve the multiple roles of supplementing the less vulnerable assured destruction elements of the Triad, provide some damage limitation against conuterforce targets, and act as a crisis management tool by rapidly supplementing other long-range theater or strategic forces. An advantage of this coupling is that it enhances deterrence by heightening Soviet uncertainty about the likelihood of conflict in Europe escalating to a strategic confrontation. The risks of nuclear destruction could thus be distributed more equitably between our European allies and ourselves.

The idea in molding a comprehensive strategic and theater policy rests on various premises:

Our ICBM force is vulnerable to Soviet counterforce attack to the point of annihilation. The various basing schemes intended to harden MX thus far appear technically and politically deficient.

It is not feasible on political, technical, or financial grounds to construct a deterrent force superior to the Soviets' or otherwise outmatch the Soviets warfighting capacity.

Strategic weapon systems have different uses though there is much complementarity among them. It is foolish to demand that each of the elements of the Triad (including cruise missiles) fulfill identical strategic missions. Unprotected Minuteman and MX missiles are too vulnerable to be the sole basis of an assured destruction posture when faced with highly accurate and large Soviet ICBMs. Bombers are poor time-urgent counterforce weapons while ICBMs and some SLBMs serve as effective first and second strike counterforce weapons.

In the light of the massive Soviet military buildup in the conventional and nuclear arenas, it is imperative that the U.S. reassert its geopolitical and security presence. Because budgetary constraints are so great, it is important to design a flexible and comprehensive force structure that is sufficiently resilient to accomplish a broad range of warfighting and theater nuclear options. We can no longer afford the luxury of maintaining redundant strategic and theater forces that are rigidly specialized across the deterrence spectrum.

Our NATO problems must be eased. In order to achieve this, the Europeans must believe that we are serious about arms control and the defense of Europe. The U.S. must achieve adequate agreement with the NATO members to assure the success of a comprehensive strategic and theater nuclear policy. There must be budgetary commitments sufficient to maintain the Alliance as a credible military deterrent before serious arms control negotiations can be concluded with the Soviets.

The United States must at all times maintain a clear and visible nuclear second strike capability, so that the United States, its allies, and its other vital interests can be protected against attack or the threat of attack by whatever means may be required.

There should be international support for arms control agreements which permit both the Soviet Union and the United States to enjoy the security of equal deterrence at much lower force levels, but to deny either side the possibility of using nuclear weapons as a tool for nuclear blackmail in the interest of aggression.

The goal of "nuclear stalemate" may be all we can achieve through negotiations—an agreement which would permit us to maintain a policy of deterrence, retaliation, and crisis stability.

The key concept of this strategy is complementarity. From the U.S. vantage point, there is considerable overlap among the components of our traditional strategic deterrent. Ballistic missiles as well as bombers serve the dual function of assured destruction and damage-limitation. Submarine-launched ballistic missiles are the core of our assured destruction deterrent and have some counterforce capability when used against airbases and land-based missiles. By the same token, strategic and long-range theater forces have complementary roles. Strategic weapons can attack theater targets while long-range theater systems can attack strategic targets as well. This interaction between strategic and theater forces is critical in assessing adequate force levels for a stable deterrent posture. By exploiting the synergy among the various components of strategic and theater forces, the twin goals of deterrence and arms control can become realistic.

## THEATER NUCLEAR FORCES

The tactical and technological reasons for theater force modernization are readily stated: The introduction of more versatile long-range tactical systems could result in fewer NATO forces being placed at risk than the current nuclear weapons deployments. They could cover more targets and could, in fact, put the SS–20 at risk.

Under the current, essentially defensive NATO strategy, a modernized long-range theater nuclear force is more useful than the present force, which is heavily weighted with short-range battlefield weapons. The present weapons are threatened by conventional attack and could be overrun within a few hours. Based to the rear, the long-range forces would place key deep Warsaw Pact targets at risk and could break the momentum of the attack. Further, they would be less vulnerable to attack at the outset of a crisis, a period necessary to achieve agreement for nuclear weapons release. Finally, long range nuclear weapons can cover whatever tactical and battlefield targeting requirements might still be deemed necessary.

In the event that NATO strategy does change, it is likely that it will focus upon the basic deterrence capability of U.S. theater and strategic nuclear forces rather than the more questionable defensive and warfighting capabilities of the shorter range tactical forces.

It is an appropriate time for the U.S. to support a shift to long-range theater nuclear systems and to argue the benefits they would have for a deterrent posture. At the same time this approach would ensure that a more modern, more useful, and, in fact, safer and more secure set of weapon systems could be deployed than those now in Europe. Today's predominantly short-range systems are in some cases now approaching 20 years old. They were built without modern insensitive high explosives or secure fusing systems. They are held at risk, particularly for the case of artillery and some of the very short-range missile systems, by conventional armaments fielded by the Warsaw Pact.

It is hard to conceive why NATO should have anywhere near the number of battlefield nuclear weapons it now possesses, or anything like the 6,000 nuclear warheads now in Europe (after the December 1979 withdrawal of 1,000 warheads), many of which are obsolete. The use of shorter range weapons is not credible to shore up a losing conventional war. We do not argue for a completed dismantling of short-range nuclear systems but rather for a shift in emphasis toward longer range weapons. One aspect of the recent decisions by President Reagan which supports this shift was to put cruise missiles on the attack submarines which can also play a tactical role in the European theater.

There are several steps that could strengthen the existing NATO modernization program. They include consideration of additional intermediate range missile deployments, increased dispersal of nuclear systems, development of a stand-off air-to-surface missile, and development of a new IRBM to extend reach and target coverage beyond the Pershing II. NATO is under strain. We have observed this week by week. We could reduce this strain to some degree by removing some part or all of the current generation of battlefield nuclear weapons because those weapons are of marginal use to NATO defense. A military requirement for such systems could be met in principle by battlefield nuclear weapons developed, deployed, and controlled by Britain and France and not by the U.S.

Seen in the light of arms control, it would be a step forward to have a substantial reduction in the numbers of nuclear weapons in Europe. Hence, a proposal to reduce the total numbers while making those deployed safer and more secure ought to satisfy at least some of the more reasonable parts of the arms control community. The U.S., having taken measures of this sort, could both increase NATO capabilities and, to its own benefit, be able to redirect defense dollars to upgrade conventional warfighting capabilities or to other federal programs now at risk because of the planned expenditures on military systems.

## POLICY AND ORGANIZATIONAL DILEMMAS

What arguments can be invoked against this proposal? There are the practical problems of command, control, and communications. These occur on a technical and a decisional level; but the organizational and command problems are as great. A similar problem with strategic forces was resolved in 1960 with the decision to designate the Commander of the Strategic Air Command as Director of Strategic Target Planning, thus providing a single focus for targeting all strategic forces. By extension, the benefits of complementary targeting of strategic and long-range theater forces can only be achieved if there is a single focus for overall targeting and weapons employment planning.

There are also policy difficulties. In effect, we will have lowered the "fire break" between theater and strategic nuclear warfare, making a confined nuclear war in Europe less likely and thereby increasing the risk of strategic conflict were nuclear war to break out. If the U.S. cannot afford strategic and theater nuclear forces to deal in a specialized manner at all levels of nuclear conflict, it has to eliminate the perceived "fire break" and achieve a compromise strategy assuring a punitive basis as the ultimate deterrent, quite limited strategic warfighting options, some direct defense against the small attack, and extended theater deterrence. In return, U.S. strategic and theater forces will be revitalized and the dream of substantial and resilient arms control will become realistic. By proposing removal of substantial numbers of short-range nuclear weapons from Europe, which hold NATO hostage to terrorist as well as Soviet attack, we can gain a quid pro quo with our allies, reducing political tensions and paving the way towards TNF modernization in Europe.

Some analysts might argue that this creates a first-strike posture by emphasizing both unprotected ICBMs and by investigating ballistic missile defense. Unfortunately, however, all long-range nuclear forces have first-strike potential. We do not pretend to understand Soviet strategic doctrine fully, but in any case a spectrum of deterrence must be introduced. Some warfighting capacity exists today: the Minuteman force is provocative; but when compared to Soviet forces, it is also relatively ineffective.

Obviously, we must continue to assess the level of the Soviet threat. This suggestion simply tries to maximize force flexibility and effectiveness in view of budgetary restrictions. However, if U.S. and NATO defense investments are too low, the net benefit of our force structure proposal would be marginal. By coupling reductions in short-range tactical weapons to deployment of long-range theater systems we avoid the possibility that the U.S. will become the sole target for Soviet nuclear forces in a war to defend NATO allies. Finally, efforts at complementary targeting of strategic and theater forces will stimulate and overall review of NATO defense strategy with the result that the U.S. and its allies could reallocate their defense resources to quantitatively and qualitatively superior conventional forces.

## THE ALTERNATIVE TO ARMS CONTROL

(ACIS Working Paper No. 36)

(By Barbara Tuchman, Center for International and Strategic Affairs University of California, Los Angeles August 1982)

### NOTE ON THE CONTRIBUTOR

Barbara Tuchman is an American historian and writer. She has worked as a research assistant for the Institute of Pacific Relations in Tokyo in 1935, as an editorial assistant for *The Nation* in Spain in 1937, and as a correspondant for the *New Statesman* in London in 1939. She is a member of the National Institute of Arts and Letters, the Authors' League, the Authors' Guild, and is a Fellow of the American Academy of Arts and Letters. She has won Pulitzer Prizes for *The Guns of August* (1962) and for *Stilwell and the American Experience in China, 1911–1945* (1971). She has also written *The Lost British Policy* (1938), *Bible and Sword* (1956), *The Zimmerman Telegram* (1958), *The Proud Tower* (1966), *Notes From China* (1972), *A Distant Mirror: The Calamitous 14th Century* (1978), and *Practicing History: Selected Essays* (1981). This paper was presented at the University of California Conference on International Security and Arms Control, April 1, 1982.

### THE ALTERNATIVE TO ARMS CONTROL

While anyone in his right mind is in favor of nuclear disarmament, I am skeptical of the capacity and willingess of governments to achieve it in any fundamental measure. The skepticism is based on the history of disarmament in our century—a long, painful, repeatedly frustrated, always futile effort. Disarmament is "a mirage and a will-o'-the-wisp," concluded Salvador de Madariaga, of Spain, chairman of the League of Nations Disarmament Commission and Disarmament Conference. No person has ever been better qualified to judge. Persistent failure of an endeavor should cause it to be re-examined, not continued forever in the same manner. Another way must be found to control nuclear war, not necessarily ruling out disarmament, but laying a new foundation for nonbelligerent coexistence. This may be the time to seek it out because a new element has entered the situation—an impelling fear.

What follows will not be a discussion of weapons and strategies nor an analysis of coupling and decoupling, windows of vulnerability, launch-on-warning, first strikes, theater deployment or any other of the nuclear esoterica. Nor will it discuss the apocalyptic consequences of nuclear use, the deaths, devastation, radiation and destruction of the human home, of which, I assume, most people are fully aware.

A major predicament of the subject of nuclear arms control is that it is virtually incomprehensible to the layman, I am a layman and I find it impossible to grasp the verifiable facts and potentials of nuclear weaponry because experts on both sides of the argument—the argument, that is, between advocates of more arms and advocates of disarming—give us diametrically different statements of fact, or what they say is fact. One side says the Russians are ahead; the other, that we are ahead; one, that we must close the gap; the other, that there is no gap; one, that they can hit us before we can hit them; the other, that the case is the reverse. The public reads statements of the number of United States warheads that range from 9,000 to 30,000, and a similar range of variation exists for the Russians. Of course, the variation depends on what is being counted, but since that is almost never precisely indicated, one cannot draw useful conclusions, and perhaps it does not matter, because no belligerent will ever have a chance to launch 9,000 warheads, much less 30,000. The public has no way of checking any of these statements or of knowing the truth; indeed, there may be no truth.

Unlike all other arms systems prior to actual use, nuclear missiles have never been tried out in maneuvers. Their explosive power has been tested but not their performance in battle or in the destruction of nations, which should make one wary of all the dogmas. If there is one thing more certain than any other, it is that wars develop in ways that are unpredictable. The Maginot line failed totally to perform the function it was designed and maintained for. The *Luftwaffe* and V-2 rockets did not knock out Britain. As between the North Vietnamese supply lines and our B-52 bombers, the result was not what the Air Force promised or expected. In nuclear war, once communications and cities are blasted, decision making could fall into chaos. How would the billigerents, if appalled by what they had done, reach each other to stop the firing? Will missiles with live warheads flown over the magnetic pole operate with the accuracy they did when tested without warheads inside our borders? What about the speculative phenomenon interestingly called "fratricide," meaning the effect of warhead explosions on fellow warheads targeted in the same direction? These are unpredictables already considered, which only means there will be many more no one has yet thought of. The area of unknowns should warn us against taking announced doctrines and strategic scenarios on faith.

At the other end of technology and strategy is the peace movement—the wish for peace, world government, brotherhood and all those goals of good will that humanity craves and has never attained. I am skeptical of peace. Peace has not figured among the notable achievements of mankind. It is the most talked of and least practiced of all social endeavors. Men—and in this case I mean the male gender, not the species—are always saying they hate war and war is hell and so forth, and have continued to engage in it lustily, aggressively and ceaselessly since the beginning of recorded history, and doubtless before. Historians have estimated that society has spent more time fighting than in any other activity except agriculture. Sumerians, Babylonians and Assyrians, Egyptians and Israelites, Greeks and Romans, Scythians, Carthaginians, Huns and Goths, Mongols and Turks, Celts and Saxons, Europeans and American, Chinese, Japanese and Moslems have fought each other or among themselves or against some opponent at every stage of civilization. Peace is brief, as fragile and transitory as apple blossoms in spring. Moreover, because it engages deep feelings, it produces sentimentalizing and distance from realism. Somewhere between the strategists and the peace movement, we must find an area for creative thinking.

It may lie in control, the control of war. Of course, that is certainly no new idea, although its history has been negative. In the early Middle Ages, when war was constant and indeed the gentry's profession, an attempt was made by the church to restrict its havoc by means of the Truce of God. During the truce, fighting was to be suspended on saints' days, Sundays and Easter, and all noncombatants—clerks, peasants, merchants, artisans and even livestock—were to be left unharmed by men of the sword. That was the theory; in practice, the truce was a sieve consisting mostly of loopholes. The concept of "just war"—that is, war in response to a wrong by the other side—was another effort to restrain the impulse to war. It was paid a great deal of attention, largely because the claim of a just cause entitled the belligerent to unlimited loot with a free conscience, loot being the primary object of medieval war. Since, as we all know, one's own motives are always just, the just-war concept never deterred anyone, as far as I am aware, from aggression. It was curious to see it turn up not long ago in a protest by members of the Harvard Divinity School calling for a worldwide freeze on production of nuclear weapons. They stated that, "While there may have been just wars in the past, the inability to place traditional constraints on nuclear war now makes any moral justification impossible." While that is admirable and true, the authors, had they been historians, would have known that so-called "traditional constraints" have never been more than a verbal screen.

The history of control belongs largely to our century, the Terrible Twentieth, whose unconfined violence has made the need so compelling. That history has included attempts at disarmament or limitation of arms, international arbitration, international organization in the form of the League of Nations and the United Nations, with covenants and sanctions and systems of collective security. Even a pact of renunciation of war was signed by all the nations that counted in 1928.

Major international effort began with the first Hague Conference on disarmament in 1899, followed by a second Hague Conference in 1907. Forced into existence by public pressure arising from fear of the swelling armaments industry and by the efforts of several extraordinary individuals, the Hague Conferences were a response to the frightening dynamics of the machine age, which seemed to be rushing toward explosion. In the same years, Alfred Nobel proposed a peace prize to compensate, one supposes, for the dynamite he had made available. The summons to a world conference, issued by Czar Nicholas II, who was behind in the arms race, surpassed the wildest dreams of the friends of peace and sounded, in the comment of a Viennese newspaper, "like beautiful music over the whole earth." Once in the hands of governments—for no government could decline the summons—and of their delegations of tophatted diplomats and bemedaled military, the results were carefully tailored to distress no war departments. Nothing done at the Hague restrained the Balkan wars from breaking out nor the explosion of World War I.

The battered nations that emerged from World War I made a serious effort toward world order in the establishment of the League of Nations and the Permanent Court of International Justice, and they made a specific commitment to disarmament in the covenant of the League. In Article 8 of the covenant, recognized by the signatories as fundamental, they argued that "the maintenance of peace requires the reduction of national armaments to the lowest point consistent with national safety." The Council of the League was mandated to formulate a plan of arms reduction for members to consider and act upon. New undertakings to confirm and carry out this purpose were added by the Treaty of Locarno in 1925.

The Committee on Disarmament worked for the next eight years in the attempt to implement Article 8, but agreement on means and principles broke down over the question of how to assure security before disarmament. General security was recognized as a prerequisite to disarmament, and sanctions against an aggressor as essential to security, but no nation was prepared to trust in the system to the point of disarming.

Meanwhile the Washington Naval Conference on 1922 actually achieved the single act of arms control of the time—not disarmament but a limitation of battleships by the United States, Great Britain and Japan in the ratio of 5-5-3, and an agreement on nonfortification of the Pacific islands. As the first such act by the great powers, it was a stunning event, supplemented by the Nine-Power Treaty guaranteeing the integrity of China. Regrettably, the soul was less handsome than the face. Because Japan furiously resented holding the short end of the 5-5-53 ratio, the effect of the treaties was ultimately negative. Resentment fueled the rising Japanese militarism that led eventually to Pearl Harbor, and the guarantee of China's integrity that Japan signed did not halt its program of expansion in China by so much as half an hour.

The League's efforts continued with the Geneva Protocol of 1924 for the Pacific Settlement of Disputes. Intended to reaffirm and strengthen the covenant, it provided for compulsory arbitration and defined the aggressor as the nation which refused arbitration. As this made the parties nervous about sovereign rights, the protocol was still-born.

Optimism revived the next year with the Locarno Treaties, which committed Germany and France to mutual guarantees of boundaries and committed Germany to pursue the course of arbitratoin in any disputes with Belgium, France, Poland or Czechoslovakia. A euphoric "Locarno spirit" prevailed and bloomed in the forever memorable Kellogg-Briand Pact engaging its signatories in the renunciation of war. The pact gained almost immediate and universal adherence because—according to one textbook that was either consciously or unconsciously cynical—"the pact only involved renunciation of aggressive war and made no provision for sanctions." In short, it was empty. Nevertheless, the ceremonial signing in Paris was greeted by Foreign Minister Aristide Briand with genuine emotion as marking "a new date in the history of mankind" and by Secretary of State Frank Kellogg's happy assurance, "We have made peace at last."

The London Naval Conference of 1930 proved unable to translate this spirit into actual disarmament. It registered some limitations on submarines and other tonnages, amiably softened by an escalator clause which allowed an increase over specified tonnage if the "national needs" of any signatory dmanded it. The descent from euphoria was under way, and was underlined a year later by the event that began the era of aggression and appeasement—Japans' seizure of Manchuria.

In 1932, the League's efforts at arms control finally culminated in the major Disarmament Conference of 59 nations at Geneva. It adjourned without result because Germany, disarmed by the Treaty of Versailles, was now admitted to the League and demanding equality, which is turn caused France to cling rigidly to the principle that security must precede disarmament. Later, at a reconvened session in 1933, Britain, France, Germany and Italy signed a No Force Declaration pledging "not in any circumstances to attempt to resolve any present or future differences between them by resort to force." Though a fine promise, it persuaded no one to disarm. But let us not wax too cynical about the verbal promises. They reflect what we genuinely wish and they keep the wish alive, even if performance fails. Humanity's eternal difficulty is that thought is never matched by practice.

Collective security now unraveled fast. When the League adopted the Lytton Report blaming Japan as politely as possible for the Manchurian seizure, Japan departed from Geneva and officially repudiated the naval agreements of 1922 and 1930. Germany left the League six months later, denounced in its turn the Versailles Treaty and announced its own rearmament based on the failure of the other nations to disarm as provided by the Versailles Treaty and the League covenant. As soon as its armed forces were sufficiently reviewed. Germany repudiated the Locarno settlement with France and its troops reoccupied the Rhineland. At the same time, Italy invaded Ethiopia in a challenge that the League powers failed to meet by sanctions. Collective security was moribund and Munich not far off.

After World War II, the nations returned to the search for a system of international control. Confronted by the atom bomb, the United Nations tried through the International Atomic Energy Agency to lasso the new beast of war, but all ropes fell short. The United Nations Disarmament Commission, earnestly plodding in the footsteps of its predecessor, worked for five years to formulate a system for the limitation and balanced reduction of armed forces and arma-
control of nuclear energy for peaceful purposes. It, too, adjourned in deadlock.
'ments, the elimination of major weapons of mass destruction, and the effective conrtrol of nuclear energy for peaceful purposes. It ,too, adjourned in deadlock. In 1959, a revised Commission of five Warsaw Pact and five NATO countries resumed the effort without success. In 1961, the General Assembly adopted a resolution declaring the use of nuclear weapons contrary to international law, to the United Nations Charter and to the laws of humanity. Comment fails. Judging by the race in nuclear weapons since these, resolutions of the General Assembly lack something in authority.

We come to 1962, the year of the Cuban missile crisis, when 30 years after the League's Disarmament Conference, the United Nations Disarmament Conference convened in Geneva over the graveyard of its ancestor, with the declared aim of general and complete disarmament. Seventeen nations—with the notable exception of France—attended under the presidency of the United States and the Soviet Union and adjourned in the usual impasse. Nevertheless, in the waters off Cuba something had happened: The shock of the near miss propelled the governments of the two parties to a serious effort at control. Together with Great Britain, they signed the Limited Test Ban Treaty of 1963, renouncing nuclear tests above ground, to which a hundred other signatories later adhered. Hailed with solemn joy as a real advancement at last by the peace advocates who had worked so hard for it, the test ban at least reduced radiation in the atmosphere. That was a gain for the environment but not for disarmament. It reduced no arsenals; it simply drove the tests underground. More tests have since been carried out underground than were previously carried out above ground. The total since 1963 is 783. In 1980 alone, there were 49, or the equivalent of four a month: 20 by the Soviet Union, 14 by the United States, 11 by France, three by England and one by China.

The Nonproliferation Treaty adopted by the General Assembly of the United Nations in 1968 and since ratified by 116 nations is a similarly qualified accord. It was meant to limit the acquisition of nuclear weapons capability. Since the treaty, that capability has been admittedly acquired by India, probably acquired by Israel, with Pakistan and South Africa said to be close behind. Argentina, Brazil and Iraq are said to be working hard on the development, with South Korea and Taiwan possessing some degree of the technology.

Meanwhile the development of a defensive weapon, the ABM, or antiballistic missile, threatened to upset—or, as the strategists say, destabilize—the system to the point of initiating a race to produce antiantiballistic missiles. As detente was still warm or lukewarm, the superpowers were sufficiently perturbed to enter strategic arms limitation talks and succeeded in 1972 in reaching the agreement called SALT I, which actually accomplished some limitation. It included a restrictive antiballistic-missile treaty and a so-called interim agreement temporarily freezing launchers of ICBM's and submarine-launched missiles at existing levels.

The inexhaustible creativity of the weapons men, however, was not frozen and they soon raised lethal powers to a new stage. As a result, talks were renewed toward a more comprehensive mutual restraint, but arms limitation travels on such reluctant feet that it took seven years of negotiations before a signed agreement was reached. By that time, relations had so deteriorated that SALT II never even reached a vote in the United States Senate.

It might be added that in 1972 a Biological Warfare Treaty, prohibiting the development, production and stockpiling of toxins and bacteriological weapons was signed by the United States, Britain and the Soviet Union. It entered into force in 1975 with a provision that any such weapons then in possession of the parties must be destroyed or diverted to peaceful purposes within nine months. Yet substantial reports have circulated of a Soviet anthrax program that violated this treaty, while the active chemical warfare recently reported in Afghanistan, if true, violated the Geneva Treaty of 1925, ratified by the Soviet Union in 1928, that prohibits belligerent use of chemical weapons. Plainly there is nothing governments sign that they will not break.

I have engaged in this long and dreary survey in order to show that control of war in the form of disarmament or limitation of arms has been a fruitless effort. Even the Encyclopedia Britannica, coming to that conclusion in its last edition, was shaken from its usual composure to the outspoken admission that the effort for disarmament in our time has been "spectacularly unsuccessful." This suggests that we should try another way. Control of nuclear war is too serious a matter to be left any longer to governments. They are not going to get it for us; in fact they are the obstacle. As the late President Eisenhower recognized in that often-quoted and very revealing remark, "People want peace so much that one of these days governments had better get out of the way, and let them have it."

What then is to be done? What change can be expected in a process that has accomplished nothing in 80 years? I think a change is possible because a new factor, terrible as it may be, has intervened: it is the prospect of finality.

Before the advent of nuclear power, war however devastating and brutal, had limits of destruction. The Mongols may have left pyramids of skulls, and the Nazis the equivalent in their gas chambers, but capacity was not global. It is often supposed, and stated, that turning war against civilians is an introduction of our century, but this is not so. The medieval way to destroy an enemy was to destroy his resources by killing off as many as possible of his working class. The punitive massacre of a city's inhabitants and the looting and burning of civilian property were normal procedures. What our century has introduced is not new inhumanity but newly extended capacity for mass destruction, and ruin of the human home.

Until now, the finality of the human race and its living space was not within the framework of expectation. Today it is, which gives the question of control an urgency it never had before. The factor is fear. It is fear that has given rise to the antinuclear movement in Europe and to the remarkable change in this country from the recent indifference to the new deep and widespread concern reflected in citizens' committees, bulletins and pamphlets, church groups' petitions, demonstrations and conferences. In November, 1981, a United States Senator, David Pryor, Democrat of Arkansas, stated the case in a few words: "People are petrified, to put it simply."

Fear may make the difference. Heretofore, we have ascribed war to human aggression, to what William James called "the rooted belicosity of human nature." "A millennium of peace," he maintained, "would not breed the fighting instinct out of our bone and marrow." Maybe not, but fear might. It is the only motive power, I believe, that could compel us toward the control of war that all the efforts of the last 80 years have not secured. It is an instrument, moreover, in the hands of the public. Governments, of course, are made up of human beings who know fear no less than ordinary mortals. But the trouble with governments is that they are moved by too many other considerations. Policy makers become trapped in illusions of power, individual ambition and self-image, vested interests, ideologies, hopes of re-election. As a result, fear has no room to energize common sense. Governments, I have concluded, cannot be looked to for genuine disarmament or meaningful arms control.

Let us acknowledge it: the American and Soviet Governments have no real desire to limit nuclear arms. They go on talking about it as they are talking now at Geneva, and this is useful up to a point because it keeps the dialogue going, but the *intention* behind the talks is questionable. Perhaps it is indicated on our side by the appointment as chief delegate to the Geneva talks of the high priests of the hardline, Paul Nitze. A rough equivalent would be putting Pope John Paul II in charge of abortion rights. Governments that distrust each other do not seriously intend to reduce their arsenals. That is understandable, but we should understand it and not expect much.

Governments, like the rest of us, know that in a conflict of nuclear powers there can be no hard dividing line between conventional and nuclear warfare: One will slide inevitably into the other as soon as the choice for one side becomes either escalation or surrender. And they know that nuclear war once started cannot be limited, because the side that is losing will employ whatever remains in its silos. Strategists nevertheless talk of limited war, but I expect that is to let them sleep at night—besides providing the material for a large and growing profession. They plan scenarios, play deterrence, juggle the acronyms, calculate delivery accuracy and counterforce capability, expound pre-emptive strike versus worst case, and intricately occupy their minds and skills in a way they could not if they acknowledged that the operation must end in a big bang. While they keep busy, the obstacle to progress is that the superpowers have got themselves into such a bind of mutual suspicion that they cannot divest themselves of a single missile. That will take a revolutionary change of attitude.

The principle necessary for such a change was stated by Madariaga. Summing up his experience as the general manager of disarmament, he wrote in his memoirs that the causes of quarrel must be eliminated first before disarmament can take place. "The trouble with disarmament," he wrote in 1937, "was (and still) is that the problem of war is tackled upside down and at the wrong end. . . . Nations don't distrust each other because they are armed; they are armed because they distrust each other. And therefore to want disarmament before a minimum of common agreement on fundamentals is as absurd as to want people to go undressed in winter. Let the weather be warm and people will discard their clothes readily and without committees to tell them how to undress."

I realize that the metaphoric warm weather is a long way off, but "a minimum of common agreement of fundamentals" is the essence. That is going to have to be our almost impossible task. If the nuclear threat is to be taken as seriously as all the passionate words of the peace advocates plead, we have no choice but to implement the Madariaga theorem.

While I do not wish to get into politics, because the problem is deeper than that, the first step may have to be recourse to Horace Greeley's slogan, "Turn the rascals out!" The Reagan Administration is explicitly, and probabaly immovably, attached to a policy of bigger and better and more arms, not less. To quote the Republican national platform of 1980, the party's object is "to close the gaps with the Soviets and ultimately reach the position of military superiority that the American people demand." This is nonsense even more than is normal for an electoral platform. I do not know whether the American people demand military superiority or not, but I know that for now and the foreseeable future it is an illusion, and delusion. If there is a gap, how is it measured? How do we know when we have closed it? The advocates of increase say it is measured by relative expenditures, but you might as well judge a beauty contest by what the contestants spend at the hairdresser. Expenditure does not tell you the quality or effectiveness of what it buys nor the combat efficiency or commitment of those who operate the weapons. Military superiority is not a tangible nor a static thing one can get or keep. If we got it, it might last a week.

For the sake of clutching at this cloud, the Administration insists upon a defense expenditure that is ultimately counterproductive because the cost will gradually erode civilian support for the defense program. Creating an unmanageable deficit and adding $50 billion each year to the national debt is the greatest cause of the inflation that is wrecking the economy and the welfare of our society. Americans may not be the most rational of people but eventually enough of them will put two and two together to demand a halt.

I cannot speak for the Soviet people from personal knowledge but I should think it unlikely that they exist in serenity. A study made in 1981 by the International Communication Agency, the former United States Information Agency, reports that while the Russians apparently do not fear direct attack, they suffer their own kind of apprehension about the United States as a power that can overwhelm them by superior military technology. In the popular view, the United States is seen as capable of changing the military balance in its favor overnight by some technological miracle that will leave the Soviet Union far behind in the arms race. Soviet governing groups, according to the study, harbor doubts "about the competence, reliability and effectiveness of their own forces." The possibility of direct conflict with the United States is no longer "dismissed out of hand," as it was formerly, although the Chinese, rather than ourselves, are seen as "the enemy" and the sense of inevitable conflict with China is "pervasive." Add to this the absence of self-sufficiency in food, the running sore of Afghanistan, the shift in their own population toward a possible majority of non-Russian peoples and a border of unreliable satellite nations, and the sum is reason enough for uneasiness.

I do not share, however, the idea that the Russians might at some desperate moment plunge into foreign war to drown their internal dangers; that seems unlikely. American theory holds that they would like to dominate, not by war, but through their possession of superior forces, nuclear and conventional, and therefore we must deploy greater forces lest we be dominated. If Soviet conventional forces started to roll across Europe, we are told, NATO conventional forces could not successfully oppose them, and therefore we would have to resort to nuclear weapons, first tactical and then, inevitably, when the enemy replied in kind, intercontinental land-based or submarine-based missiles.

Given nuclear weapons and their consequences, one thing is clear: *There is no military solution* to the problem. The confrontation of their system and ours has, I repeat, no military solution. I noticed that one of the Congressman who went to El Salvador in February, 1982, to investigate the situation recognized this in the microcosm of that struggle. "I don't think," Representative James K. Coyne, Republican of Pennsylvania, was quoted as saying, "we can develop a military solution." That was astute and, as Coyne's Law, could justifiably be extrapolated to cover the larger rivalry of the United States versus the Soviet Union. Whatever the strategists and militarists and present-danger propagandists have to say about war-fighting, as they oddly like to call it, there is no war of nuclear powers now that can be won, or could end short of extinction. Earl Mountbatten, citing his 50 years of military service, told the public shortly before he was killed in 1979 that "the nuclear arms race has no military purpose. Wars cannot be fought with nuclear weapons."

That they must have the weapons anyway is the position of the Soviet and American Governments. This policy can only be deactivated, I think, by public rejection. There can be no real progress toward arms control until public tolerance of existing policy ends. When public tolerance stops, piling up overkill must stop, because as Christoph Bertram, the director of the International Institute for Strategic Studies, recently acknowledged, "without acceptance by the public, there can be no sustainable policy." The European antinuclear movement has already shown that governments and parliaments respond to public pressure if for no other reason than fear of losing the next election. The deepest emotion of any person in high office is desire to stay in. The public wish not to be obliterated and not to be despoiled by grotesque military spending and insane national debt must make itself effectively felt. Military needs must be brought into proportion with the other needs of society, social and cultural.

When control of arms becomes a goal of the mainstream, then it will prevail. The working instrument is votes. Every candidate for elective office each November should be asked to state for the record his position on the arms race. I am not deluded enough to suppose that reason will suddenly take possession of the human race and that a majority of every community will see the light of common sense within the next six months. I am a historian, not a mystic. Nor am I a Maoist believer in the ultimate wisdom of the "people." "Your people," said Alexander Hamilton unkindly to Thomas Jefferson, "is nothing but a great beast." but even a beast may balk at the edge of an abyss.

Public demand should continue for a bilateral nuclear freeze, ratification of SALT II, a ban on all nuclear testing and, above all, for a firm renunciation of first strike by act of Congress. These are necessary both to inform the public and maintain the pressure. Dramatizing the issue is Ambassador George F. Kennan's proposal for a sweeping 50 percent bilateral reduction of all nuclear arms without further discussion, to be followed by a further reduction of two-thirds of what remained. This cuts through the rhetoric and notifies us all how serious is a serious man's estimate of the situation. Yet with all due respect to Ambassador Kennan, something else must happen first.

I come back to the Madariaga theorem: The source of hostility must be eliminated or mitigated before nations will give up their weapons. Most people would say that to eliminate hostility between Communism and free enterprise is impossible. I will grant that it is very difficult, but not more so than disarmament, which has eluded our efforts so far; therefore we might just as well try another way. If all the energies, skills, intelligence and at least half the money we have put to the use of the arms program were employed instead in an effort to reach accommodation or modus vivendi—that is to say, a way of living, not dying—we might in fact find it.

This does not mean we have to be friends. Friendship between a representative government based on liberty of the individual and a totalitarian government based on submission of the individual to the state can never be natural. We are not on a common path; we do not have political methods and principles in common; we share only one common goal—survival.

As long ago as 1957, the late Gen. Omar Bradley saw this as the path. He asked why "we do not make greater, more diligent, more imaginative use of reason and human intelligence in seeking an accord and a compromise which will make it possible for mankind to control the atom and banish it as an instrument of war. . . . It may be that the problems of accommodation in a world split by rival ideologies are more difficult than those with which we have struggled in the construction of ballistic missiles, But I believe that if we apply to these human problems the energy, creativity and perseverance we have devoted to science, even problems of accommodation will yield to reason."

That is such a brave belief that I could not resist quoting it. Instinctively, I share it, although I know from the study of history that reason does not control human motivation. Still, there are measures we might try. One would be a more massive, more purposeful effort than may now be conducted to promote antinuclear sentiment and fear of their own policies among the people of the Soviet Union and satellite countries. We are always blaming the Russians for agitating the peace movement in Western Europe. Why should we not do the same behind the Iron Curtain? We could also try what might be called the stuffed-goose option—that is, providing them with all the grain and consumer goods they need in such quantities that they become dependent on us and could not risk the domestic turbulence that would follow if they cut off the source of supply by war.

Mistrust has to be tackled and that is the hardest task. Diplomats and journalists who have dealt with Soviet officials see small chance of breaking through the granite wall of their recalcitrance. Yet living as we do now under a cloud of imminent explosion is too expensive and too socially destructive. We must find the way to coexistence without violence. If Germans and French, after centuries of hostility and three major wars in the last hundred years, could do just that from sheer necessity, I suppose we could, too. This is easily said but it is a deeper, more basic enterprise requiring more radical readjustment of national thinking than another round of balancing your missiles against my missiles. A start might be made if leaders came to power in Washington and Moscow at the same time who both really *wanted* accommodation. Only both publics can make that happen.

Senator WARNER. Have you had an outside professional group look at fireproofing your laboratory? I think I told you a little bit of history, that my first job in life in 1943 was as a firefighter. I was greatly concerned with all the inflammable trees and debris bordering your laboratory.

Dr. KERR. As you are perhaps aware from your visit, there was a large forest fire that burned some 7,000 acres adjacent and, in fact, on part of the laboratory, itself. The laboratory, like other parts of the weapons complex, was reviewed after the Rocky Flats fire some years ago by American Mutual and many recommendations were made for fireproofing. We have, in fact, completed carrying out the majority of the retrofits for sprinkler systems and other protection for our high value equipment and high value facilities.

We have not yet completed all of it at this point; it is part of the continuing refurbishment and rehabilitation program.

We anticipate completing that over the next couple of years.

With regard to the forest management aspects, the Forest Service has been working much harder than in the past to clear out underbrush to avoid the chances of either a natural or man-caused fire that might spread on laboratory property.

We also have cut down a lot of trees and cleared areas for the same reasons onsite.

Senator WARNER. The U.S. Forest Service has a good technical group on questions of fire protection. Have you engaged their assistance?

Dr. KERR. We work with the Forest Service directly. Their land adjoins the Department of Energy land in Los Alamos County. Their forest management people work with us relative to what we do on DOE lands. Yes, we consult with them. We believe they are among the best. After all, they are the people who manage the western forests most susceptible to fire.

Mr. ROSER. This is a long-standing relationship, Senator. We have had that relationship with the Forest Service for a long time. We think it is very important and it will continue.

Dr. KERR. We have also had a very wet winter; that helps with all the planning we might do.

Senator WARNER. Thank you, Doctor.

## STATEMENT OF ROGER E. BATZEL, PH. D., DIRECTOR, LAWRENCE LIVERMORE NATIONAL LABORATORY

Dr. BATZEL. With your permission, I will use the Vugraph.

My intention is to cover four areas, briefly. I want to give a status report on our nuclear weapons program within the lab, something about its accomplishments, something about needs and prospects. I want to take a look at our perspective of Soviet technology in nuclear weapons. I want to mention the status of the inertial confinement fusion program, and then comment on a recent development on plutonium isotope separation.

First, this is a list of accomplishments. [Chart deleted.] I will not go through each of them in detail. I would like to highlight two or three of these.

[Deleted.]

Just to reinforce the statements of Dr. Dacey, Dr. Kerr and Mr. Roser, this chart [chart deleted] shows the level of personnel at the Lawrence Livermore Laboratory devoted to nuclear weapons technology.

You can see that in the last 10 years there has been a significant overall reduction, and with our commitment to current weapons and providing an essentially base weapons technology which, to a major extent, supports the current weapons, we have little time for advanced-concept efforts. I think that work on advanced concepts is one of the specific responsibilities you expect us to conduct; namely, we have to know what is possible in nuclear weapons technology.

[Deleted.]

Senator **Warner.** Before we leave that, is there any chance of getting that declassified?

Dr. **Batzel.** [Deleted.]

Senator **Warner.** Suppose I drew up my own chart for the purpose of testimony before the Foreign Relations Committee, not an official one but just a chart in inaccurate form, if for no other reason but to show the divergence of the trend?

Dr. **Wagner.** I think it would depend on what you said.

Senator **Warner.** I would explain that these are inaccurate but basically they show the trendline.

Mr. **Roser.** I don't think that anybody could challenge you, sir.

Senator **Warner.** Every 6 years this politician is challenged at the polls. Beyond that, he is autonomous. I have never in my public career divulged classified information and never will, but I am anxious to get this case across to the public. I have some skill at communicating with the public and one chart is worth a thousand words, just showing those lines; you don't have to put down floor space or manpower but here is the laboratory system of the Soviet Union; here is the floor space of the U.S. labs. Give me some advice as you go along. I don't want to pin you down now.

Mr. **Roser.** We will work on that. I think it can be furnished to you in a form that is not classified.

Senator **Warner.** Just something simple.

Dr. **Batzel.** [Deleted.]

### INERTIAL CONFINEMENT FUSION

Now, to change subjects, this relates to the inertial confinement fusion program. The Nova facility is under construction and we are looking forward to having that facility available to us in the next 2 or 3 years. [Deleted.]

With that, I propose to stop. Thank you.

Mr. **Roser.** Mr. Chairman, that completes the witnesses we have.

We will be happy to respond to any other questions you have, or any questions for the record, sir.

Senator **Warner.** In view of the hour, I am going to put my question for the Department of Energy in the record.

Again, in repetition of what we have been talking about this morning, we need your help. You are a repository of knowledge.

Now, this book came out on Friday, entitled "Senator Kennedy and Senator Hatfield's Freeze." There is not a copy left anywhere. It is in its second reprinting right now. I am going to give you my copy. I am trying to get two more, one for each laboratory director.

I am going to ask you to please take it with you and read it. I have copies for each of you of the resolution by Senators Hatfield and Kennedy, and the resolution by Senator Jackson and myself. I hope to give you this to go back with.

What I am trying to do is get your knowledge and that of your colleagues on how to approach this rebuttal in a responsible way. I am not characterizing this as irresponsible. I have not had a chance to read it yet. I am just going to spend every waking minute of the day that I can in the next few weeks putting something together for my colleagues on a side-by-side basis.

I know that you have the objectivity, the background—as I met and talked to each of you—while you are scientists, you also have impressed me with a good deal of your ability to understand how to deal with these things in the public domain. Please help me on this. If you can get to me your comments, just initial ones, by Monday, and then follow up, I will be deeply grateful.

Mr. ROSER. We will certainly lend every effort. I will speak not only for myself but also for all of our colleagues. We are most anxious to help you. We will bend every effort to lend every bit of support that we can. We think you carry the ball for us. We think you carry the flag.

We think it is tremendously important not only to us but also to the country. That is what we are after. You have my word.

Senator WARNER. You are doing this for your country. I want to be accurate and honest with the American people. You see, some can just seize on a statistic and use it: They are not required to go back and substantiate it. We want to be accurate and yet stay within the confines of our own classification system. The security issue can be a handicap in getting the full story to the American people.

Mr. ROSER. Yes, sir, it is a handicap sometimes. We want to try to get it to be the least handicap that is necessary in this particular context.

Senator WARNER. Thank you.

I will endeavor through Jim Smith to get this material to you today. You will help me on this and help the members of this committee?

Mr. ROSER. Yes, sir.

Senator WARNER. Thank you very much.

I want some background on the President's public statement of our military inferiority. I recognize that the full answer embraces some areas which are not directly within your control, but give me your thoughts on that.

I understand that your responsibility is technical to produce the warheads; but you have the major piece of this equation of strategic inferiority. I would ask you to expand on precisely what the President said. I have to be prepared to respond to questions on his statement. I want to answer them factually and accurately. You really have a reservoir of the facts, together with the Department of Defense, to provide additional background.

Dr. WAGNER. Senator, I can certainly work with the DOD agencies and provide backup on that.

Senator WARNER. I have talked to both of your bosses on this. I do need your help. If you can give me the facts and guide me with respect to the parameters, not to violate classification, I will speak out on these points—I don't worry about my own skin—and make the case. I want to make it an accurate, honest case to the American public and indeed the whole world. That and the economy may well be the key questions in the 1982 elections. I am not talking about just electing representatives; I want the country to know what the facts are.

We have managed strategic systems as trustees for decades, a small fraternity of people. The foreword of this book is written by Averell

Harriman. We saw McNamara, the former Secretary of Defense, on television the other day. I had to appear on television and debate one of the closest friends I have in the Congress, John Rhodes, who is of the opinion that we can stop. It is not a partisan thing; it is a struggle to get accurate information before the American public on a factual basis, and then they have to make up their own minds.

Thank you for indulging me this morning on a little more rhetoric than usual. Thank you very much.

Mr. ROSER. Thank you, Mr. Chairman, very much.

Senator WARNER. Admiral, what a pleasure it is to see you. I just can't tell you how pleased I am with your willingness to continue to serve in the U.S. Navy in this present position. Since I have heard very little, I presume the transition went smoothly?

## STATEMENT OF ADM. KINNAIRD R. McKEE, USN, DEPUTY ASSISTANT SECRETARY OF ENERGY FOR NAVAL REACTORS

Admiral McKEE. Yes, sir; it has gone remarkably well.

Senator WARNER. I hope you will touch on that in your prepared statement. I see that you have put together a comprehensive program. Maybe you can just give me the highlights. We will put your entire statement in the record. Take all the time you want to explain what points you think are the ones the committee should focus on here.

Admiral McKEE. Thank you, Mr. Chairman. I am very happy to be here. The couple of months since I appeared before you the last time have gone quickly. I told you at that time I was walking into a superb organization, and everything I have seen since then confirms that notion.

### NAVAL REACTORS ORGANIZATION

I have a remarkable collection of good folks. But beyond the personnel, the preservation of the joint nature of this program has been particularly important. It has become more and more apparent to me that very few people in this town understand the unique aspect of this organization; it is a cradle-to-grave operation. It begins with basic research and progresses through operation, overhaul, and eventually disposal of the naval nuclear propulsion plants.

I never lose the responsibility for the propulsion plants and the ships we build. Even after they go out of commission, they still remain my responsibility. This responsibility also includes the training of crew members for the nuclear fleet.

Senator WARNER. We want to discuss at some point your personal opinions concerning what Congress should do vis-a-vis your charter which is presently in the form of an Executive order. You are aware of some efforts here in the Congress by Senator Jackson and myself to put that in a more formalized fashion. Maybe it is a little early to make that conclusion, but whatever you would like to tell me.

Admiral McKEE. As you know, Executive Order 12344 dated February 1, 1982, codifies the current operation of the naval nuclear propulsion program.

My initial reaction was that the Executive order was sufficient. However, the more I study the matter, and the more I deal with various pressures on this organization, the more convinced I am that you are right.

Senator Warner. You and I have known each other a long time. You just come and talk to me quietly when you have an opinion on this subject. I think your experience will help whatever efforts we make jointly more credible. I know of what you speak.

Admiral McKee. Yes, sir. I will come back and talk to you about it separately.

You are familiar with the record of this program, but I am going to say a couple of things about it because there are some comparisons I want to draw that are important.

### NAVAL NUCLEAR PROPULSION PROGRAM

You understand that 40 percent of our current Navy combatant warships are nuclear powered. There are 134 nuclear-powered ships, with 30 more authorized. These ships operate under the most demanding circumstances. We push them harder than other ships, yet their overall combat readiness—and I'm talking about the whole ship, not just the propulsion plant—is almost twice as high as the——

Senator Warner. What is the total number of ships?

Admiral McKee. 134 right now, with 30 more authorized.

The overall combat effectiveness of these ships is very high, much better than the Navy average. The question is "Why?" It is hard to draw a parallel between these and other Navy ships. One of the reasons is the quality, training, and basic operational instincts of the people who run the nuclear powered ships. The naval nuclear propulsion program has over 2,400 reactor-years of operating experience without a reactor accident or release of radioactivity that has affected the environment. In spite of doubling the number of ships since 1966, the total radiation exposure to people in the program is down to about one-sixth the amount of the peak year, 1966.

Senator Warner. As you know, the problem that the private sector has experienced thus far has undermined nuclear power with the public to a point where it is ready for the grave. It is predicated on their problems.

Here, in a parallel sense, the U.S. Government in the area of defense has operated 134 plants with an astonishing safety record.

Admiral McKee. It is something that requires a thoughtful response. I will give you a couple of things to consider. You may have already heard some of them from Admiral Rickover. One of them is that the head of the naval nuclear propulsion program is totally responsible for all naval nuclear propulsion plants from inception to disposal. That means that the people who design these plants and the people who deal with the day-to-day technical decisions know that they will never be able to walk away from their responsibilities.

There is a remarkable amount of individual authority and responsibility among senior members of my organization. They exercise that responsibility extremely well. They all feel a very personal accountability that has developed through long association with the program.

I have a senior technical staff that has been with the naval nuclear propulsion program for many years. My refueling director is in his 28th year. The engineering manager who does the secondary plants in new classes of ships has been there 24 years.

Senator WARNER. The Rickover deputies are now gone. They are not the ones who came to the Pentagon?

Admiral McKEE. Several senior people retired from the program several years ago. However, there are still dozens of senior people in the organization with 20 years or more experience. The point I want to emphasize, however, is that with one guy clearly in charge you can hold him responsible for how the plants are designed, how they are operated, and how they are built. You can't draw a priority on those things. The same person is also responsible for setting the standards for training. Again the unique thing about this program is that you constantly have to demonstrate the competence and ability to do the job. Every year you have to prove again that you know what you are doing. For example, the engineering officer on a nuclear powered ship has to pass an examination given at my headquarters. Several years later when it comes time for him to be a commanding officer, he goes back and gets subjected to an intense period of training and another equally detailed examination on the specifics of the propulsion plant, how it works, and what his responsibilities are.

Senator WARNER. Are you going to be able to continue those personal interviews?

Admiral McKEE. Yes, sir; I am continuing to interview every prospective nuclear trained officer.

### RETENTION

Senator WARNER. How is your retention program now?

Admiral McKEE. It is on the upswing, helped considerably by the work you did giving us some additional compensation for our officers. The officer retention rate in submarines is projected to be 37 percent for fiscal year 1982, with further improvement projected for fiscal year 1983.

Senator WARNER. Is that the first term break?

Admiral McKEE. This is for nuclear trained officers.

Senator WARNER. The first term?

Admiral McKEE. Yes, sir. The enlisted retention has improved dramatically. For example, retention of nuclear trained enlisted personnel on submarines is up to 55 percent, for first term, and on the order of 80 percent retention for the second and third terms.

Senator WARNER. That is just in the nuclear area?

Admiral McKEE. Yes, sir.

Senator WARNER. Are they running higher than the Navy overall?

Admiral McKEE. Yes, sir. At one time, it was lower, as you recall, but then you took the steps to improve compensation. These guys are very bright and they understand how to use the basic principles of engineering. With the foundation they have; they are a remarkable national resource as citizens. They are exceptionally versatile. I wouldn't say that the people who leave the program all go into the commercial nuclear power industry. They are in great demand everywhere because they are well-educated, capable engineers who have grown up very rapidly under extreme pressure, with a lot of responsibility. After their first 5 years of service, they are well ahead of their contemporaries in the commercial sector. This makes them a very marketable commodity.

We, in the Navy, are never going to be able to pay the same wage that a man with that kind of experience can get on the outside. But if we come close enough, and if those of us in uniform do a good enough job of making our junior officers understand that what they are doing is the best thing in the world, I think we will be all right.

It takes a special kind of guy to do this for a living, a young man who has a lot of confidence and a lot of integrity. He must also like to live with his head in the tiger's mouth. We have to encourage that—I think we do. Often we get caught up in our own rhetoric. When I interview a young ensign, the first thing I ask him is, "What do you want to be?" He says, "I want to be in the nuclear power program." I say, "What is that? What is the nuclear power program?"

Senator WARNER. That must give him a start.

Admiral MCKEE. "Do you want to be a submarine officer or a surface-warfare officer? You are here to be a sailor, not just an engineer."

To be a submarine officer is important and can be exciting as well as demanding. You do things nobody else can do. If we can convey that to these young people and if you pay them enough so that they don't go broke while they are on patrol, we will keep them. I am sorry about that filibuster, but I feel strongly about the issue.

Senator WARNER. I have filibustered most of the morning, but you can go on.

Admiral MCKEE. It is one of my favorite subjects. I was talking to a Governors' conference on education in Mississippi last week. We had a breakfast meeting. You remember General Wilson, the Commandant of the Marine Corps? He lives down there now. General Berry, who used to be Superintendent of West Point, was also there. They asked me to speak extemporaneously for a few minutes. I got wrapped up in this same subject and talked too long.

Senator WARNER. I am still fighting for the MX, but if it gets out of hand, it is all in your lap. I say all, the division between air and sea, with the emphasis on the sea.

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## MANNING

Admiral MCKEE. We accept that responsibility. There is a lot of mythology surrounding the submarine force. I talked to a civilian member of the Government this morning who wondered why I was not more interested in automating propulsion plants in our submarines to cut down the number of people who are needed to operate it. But consider how few people we already have running our submarines. In an 18,700-ton warship, the Trident submarine, probably one of the most complex warships that has ever been built, the crew consists of 157 people—15 officers and 142 men.

Senator WARNER. 18,700 displaced tons?

Admiral McKee. Yes, sir.

Senator Warner. That was a World War II cruiser, was it not?

Admiral McKee. That is slightly bigger than a World War II heavy cruiser.

Senator Warner. It is in the *Guam* class?

Admiral McKee. No. The Trident submarine is smaller than the *Guam* class battle cruisers were.

Senator Warner. Do you remember the battle cruisers?

Admiral McKee. Yes.

Senator Warner. I forget what our displacement was.

Admiral McKee. Somewhere in the range of 25,000 to 30,000 tons. They were long, lean ships.

Senator Warner. I remember them well.

Admiral McKee. The SSN-688 attack submarine has 13 officers and 114 men—127 people. Without throwing rocks at other parts of the Navy, I should point out it takes 203 people to man a frigate and 330 people to man a destroyer. So, look at what the nuclear-trained crew has to do with roughly half the number. They have a far more difficult job. It takes a very special kind of individual, and we have them.

I think if we can keep the compensation momentum that you have established, and if we, in uniform, do a better job of making them understand the principal focus of their efforts—running a warship and meeting combat effectiveness—as well as giving them a chance to stick their heads in the tiger's mouth every now and then, that trend will keep going.

If we don't do that, all the money in the world will not solve the problem.

## RESEARCH, DEVELOPMENT, AND FLEET SUPPORT

I have digressed. Let me talk a bit about what I am trying to do with the naval nuclear propulsion program. There is no question—ours is one of the best technical organizations in the world. The personnel are very talented. Our efforts are aimed not only at conducting the research and development essential to supporting shipboard nuclear propulsion, but also at direct support of the operating fleet of nuclear-powered ships. [Deleted.] What I am trying to tell you is that the development never really stops. If you ask what is the focus of that development, both for the future and for now, I bring it down to this: Combat effectiveness. There is a great tendency, I think, for military analysts to separate pieces of the ship and talk about the gun here, the missiles there, the sensors somewhere else. Somehow, the propulsion plant really is not considered part of the tactical entity. But, of course, it is.

You recognize from your own experience that a warship dead in the water is not very much of a threat. It is a threat only to itself. One of the things we are starting to look at is, how do we get the most out of the ship. What are the combat characteristics that we must have? [Deleted.]

We are looking toward the advanced fleet core for the same sort of thing. We need to take advantage of the things that we know how to do best to get more out of what we have.

Specifically then, what are we doing in terms of development?

You know, Admiral Rickover's focus for a number of years was on longer core life, trying to get the core to last the life of the ship. You can save a lot of money if you can do that. Also, you significantly reduce radiation exposure. Perhaps most importantly, if a war were to start, each ship would have plenty of fuel to operate, so you get full use out of all the nuclear powered ships. That is important and I intend to continue that development work [deleted].

Senator WARNER. Does your jurisdiction go through the power train and the screw?

Admiral McKEE. We design and build the whole powerplant, including the secondary plant, back to the shaft.

Senator WARNER. You stop at the shaft?

Admiral McKEE. We don't build the shaft or the propeller.

Senator WARNER. Right there, in connection with the propeller, that is where you stop?

Admiral McKEE. We don't build the shaft either. We do the design and integrate the steam plant with the reactor plant. We use some steam plant machinery that is developed by other parts of the Naval Sea Systems Command. We do not run a separate development effort for the steam plant, but we work very closely with them.

Senator WARNER. The Trident submarine is going to come under increased scrutiny in the Congress in terms of being one of the escape valves if, in fact, we get snarled up on our land-based system. How is the powertrain in that?

Admiral McKEE. It has performed magnificently. It has done everything we have asked of it. The ship is better than we expected.

Senator WARNER. It exceeds the specs?

Admiral McKEE. Yes, sir.

Senator WARNER. Given a free hand, you would not redesign it?

Admiral McKEE. [Deleted.]

[Deleted.]

Senator WARNER. Just a couple of basic questions:

Not having had the opportunity to review your statement, your funding level is what, compared to last year?

Admiral McKEE. My funding level is $61.7 million higher than it was last year.

Senator WARNER. On a base of what?

Admiral McKEE. $359.1 million.

Senator WARNER. You have only been in office 6 weeks——

Admiral McKEE. Three months, sir.

Senator WARNER. Is that an adequate budget for you?

Admiral McKEE. Yes, sir; it is enough to do the job. We won't ask you for more than we need.

Senator WARNER. I know your predecessor, as austere as he was, was very sparing in that area. I somehow think that era might be over.

Admiral McKEE. I think we are all right, although I have to confess I put a rug on the floor in my office.

Senator WARNER. It is the office he occupied?

Admiral McKEE. Yes, sir. The rug is the first big step on the road to degradation.

Senator WARNER. You have a little light in the outer office for a change?

Admiral McKEE. Yes, sir. I had that done, too.

Senator WARNER. For the present time, those facilities will meet your requirements?

Admiral McKEE. Yes, sir. The most important facility in our budget is construction of a second naval nuclear fuel factory at the Savannah River plant run by the Department of Energy. You know about that.

Since I talked to you last, I have been down to look at the existing naval nuclear fuel facility, Nuclear Fuel Services of Erwin, Tenn. I have also been to Savannah River, to see what they are doing there now. That is underway and I think it will be a good, tight operation.

Admiral Rickover previously estimated the cost of the fuel factory at about $300 million. That was later refined to $200 million. We now estimate the cost to be $176 million. That figure is for construction, not operating costs.

We are trying to do it in a cost effective manner, but as quickly as possible, because the single-source situation we currently face is a worrisome thing.

Senator WARNER. With the budget amendment, do you have adequate funding for a new fuel facility?

Admiral McKEE. Yes, sir, we do.

Senator WARNER. Admiral, any other points that you have to make?

Admiral McKEE. No, sir.

[Prepared statement of Admiral McKee follows:]

### PREPARED STATEMENT OF ADM. KINNAIRD R. McKEE, DEPUTY ASSISTANT SECRETARY FOR NAVAL REACTORS, DEPARTMENT OF ENERGY

During my confirmation hearings before your committee in February, I made several points that warrant repeating

First, I am firmly committed to the high standards that have always governed the Naval Nuclear Propulsion Program and to seeing these standards are met in our day-to-day work.

Second, in the three months I have been on the job, I have been pleased with what I have found: competent people with many years of experience; technical integrity throughout the Program; a commitment to excellence in all aspects of the work; and enthusiasm for the job.

Third, preserving the Naval Nuclear Propulsion Program as a joint effort of the Departments of Navy and Energy is extremely important.

The Naval Nuclear Propulsion Program is a unique organization. I know of no other organization in Washington that has cradle-to-grave responsibility for all technical aspects of a program—from the inception of design through development, manufacture, installation, testing, operation, maintenance, and disposal of the plant at the end of ship life. This responsibility also extends to the selection, training and qualification of reactor operators as well as ensuring reactor and personnel safety. Accountability for all this work in one person—the Director, Naval Nuclear Propulsion Program—ensures a pragmatic approach to engineering. New design work takes into account important feedback from operating ships. It instills in Program personnel that special sense of responsibility that comes only from knowing they must live with the plants they designed.

Executive Order 12344 preserves the vital organizational arrangement and relationships needed for the continued effectiveness of the Naval Nuclear Propulsion Program. This codifies an arrangement that has worked well over the years, permitting safe application of nuclear power to the propulsion of naval vessels. The record bears this out:

(a) Over 40 percent of our Navy's combatant warships are nuclear powered—121 submarines and 13 surface ships. There are over twice as many operating naval nuclear reactors as there are U.S. commercial nuclear power reactors.

(b) Nuclear powered warships are operated harder than conventionally powered warships, yet have the highest overall combat readiness.

(c) In 2400 reactor years of operation and 50 million miles of steaming there has never been an accident involving a naval reactor, or any release of radioactivity which has had a significant effect on individuals or on the environment.

(d) Despite a doubling in the number of nuclear powered ships, total program radiation exposure has declined to about one-sixth the amount in the peak year of 1966. All the work associated with operation and maintenance of naval nuclear propulsion plants during that period has been conducted without any Navy or civilian person exceeding Federal exposure limits.

Despite the fine record, there remains much to be done. We are continuing our efforts to improve the combat effectiveness of future nuclear powered warships; to maintain the combat effectiveness of our existing ships; and to improve the accession and retention of high quality nuclear propulsion plant operators.

Our objective is to ensure our ships can carry out their assigned missions in war as well as in peace; in other words, they must be combat effective.

Combat effectiveness is the ability to defeat a capable, well armed adversary. To do this our warships must be able to:

Get to the scene of operations;
Find the adversary;
Establish control of the tactical situation;
Deliver the attack; and
Recover from battle damage and survive to fight again.

To be able to do most, but not all these steps is not enough for a tactical commander.

The major warships of World War II were designed and many built before the war broke out. Fortunately, the ships were sufficiently versatile that imaginative commanders could use them effectively in missions and tactical situations far different from those envisioned by their designers.

Likewise, the warships we built today will be the mainstay of our Navy well into the next century. They must be reliable and versatile platforms that can adapt to the needs of that period.

Nuclear-powered warships are capable of operating virtually indefinitely at high speed and never need fuel oil support for propulsion purposes. Our nuclear powered submarines can operate where no other U.S. forces can go—operating independently and unsupported in waters controlled by the enemy. Our nuclear-powered aircraft carriers and cruisers provide a powerful, visible and highly flexible extension of U.S. military might without concern about territorial borders.

In the furtherance of combat effectiveness, we are continuing to work on improving the performance of our reactors without compromising ruggedness and dependability.

There is a popular myth that the Naval Nuclear Propulsion Program has been overly conservative; that it does not keep abreast of the possibilities of other reactor systems that offer potential for higher thermal efficiency. I have devoted a great deal of time since reporting on this job reviewing this area. I can assure you this organization has given careful attention to a wide range of reactor concepts, and will continue to do so.

Naval nuclear propulsion plant design, of necessity, requires balancing the often competing objectives of performance, endurance, reliability, weight, safety and maintainability. In engineering there are no "free lunches"—only tradeoffs. After about 18 years at sea in submarines, I can attest to the payoff of sound propulsion plant engineering where it counts—in military capability at sea.

Although the performance record of our nuclear propulsion plants has been exemplary, we will keep abreast of developments that may offer the prospect of improved performance and reduced cost. Each reactor concept offers certain theoretical or practical advantages over the others. But the yardstick against which each alternative will always be measured is the need of the ship and, for warships capable of meeting the objectives I described earlier, our determination must be on the basis of applied engineering, not theoretical concepts.

In the meantime, we will continue to develop improved pressurized water nuclear propulsion plants to meet naval requirements. The decision to use light water reactor technology has been based on practical engineering considerations determined by the nature of naval operations—not on personal preference.

The Naval Reactors Development portion of the Naval Nuclear Propulsion Program is funded by the Department of Energy and is directed at improving reactor performance—increasing the power capability and extending core lifetime. We are working to improve the power density of reactors to increase speed and acceleration—two valuable military characteristics.

We are also working to extend core lifetime. With longer core lives, a higher percentage of our ships will be available for instant deployment without consideration of their remaining fuel supplies. In addition, longer life cores save money and radiation exposure associated with refueling, reprocessing, and disposal of spent cores.

The Naval Reactors Development budget totals $421 million in fiscal year 1983, including $45 million in operating and construction funds for the naval nuclear fuel factory which has been included by amendment to the President's fiscal year 1983 budget request. The fuel factory is particularly important to ensure an uninterrupted supply for projected program needs. Initial funds were provided in fiscal year 1982 and work on this project is presently underway.

Development of basic technologies for cores, reactor plant components, and support equipment with longer life, improved operating characteristics, and higher power will continue as a high priority effort. We will also be working to assure safe, stable, and reliable performance in extended operations at higher power.

We are currently testing in one of our prototype plants an improved core with higher power density, increased reliability, and longer life than present cores. It should provide about 15 years of ship operation before refueling.

The Submarine Test Core is being designed to test advanced reactor materials under actual operating conditions in an existing prototype plant.

The Advanced Fleet Reactor is being designed to take advantage of new fuel element concepts leading to higher performance cores.

A broad program of physics, materials, components, and manufacturing process technology development is also underway to improve reactor performance. Our eight Department of Energy-owned prototype plants are instrumental in enabling us to operate, test, and evaluate these concepts in actual operating conditions without disturbing the fleet.

The achievements of the Naval Nuclear Propulsion Program are due to high standards, attention to detail, and effective execution. This requires utmost care in selection, training and qualification of those involved in the operation and maintenance of our nuclear propulsion plants. The personnel standards are high, the training is arduous, and the demands placed on shipboard personnel are heavy resulting in long hours and strain.

In addition to classroom work, prospective Navy operating personnel are trained on actual operating reactors—the eight prototype plants I previously mentioned. This practical training of operators on fully operational reactors is an indispensable element of the qualification program that underlies our safety record.

Long sea tours and attractive civilian employment opportunities make it difficult to attract and retain the high caliber of naval personnel required to operate nuclear propulsion plants. Thanks to Congressional action in providing additional pay and incentives, however, the trend in accessions and retentions is improving. We are not yet "out of the woods". For example, the retention of nuclear trained surface line officers and enlisted men is still too low. We will continue our efforts to achieve acceptable accession and retention levels.

In summary, I am pleased with the Program I have inherited and look forward to the challenges ahead. There will be no reduction in standards, or changes in the proven practices that have been instrumental in achieving the level of competence and technical integrity we currently enjoy in every aspect of the Program.

I will continue to ask for only the funds we need and, as always, will continue the Program's tradition of fair value for the funds that Congress has given us for this important work. I will very much need your continued understanding and support.

I have attached a more detailed explanation of the Naval Reactors Development budget request and two annual Navy reports on occupational radiation exposure and environmental controls in the Naval Nuclear Propulsion Program. I would be glad to answer any questions.

[Attachment]

## FISCAL YEAR 1983 DEPARTMENT OF ENERGY BUDGET REQUEST FOR THE NAVAL REACTORS DEVELOPMENT PROGRAM

The Naval Reactors Development program provides for the design, development, testing, and evaluation of improved naval nuclear propulsion plants and reactor cores having long fuel life, high reliability, improved performance, and simplified operating and maintenance requirements. The nuclear propulsion plants and cores cover a wide range of configurations and power ratings to meet warship requirements ranging in size from small submarines to large surface ships.

The Fiscal Year 1983 Naval Reactors Development budget request is $420.8 million. The details of the request, by category are:

| | *Budget authority (in millions)* |
|---|---|
| Plant development operating expenses | $58.0 |
| Reactor development: | |
| Operating Expenses | 160.0 |
| Capital equipment | 11.0 |
| Construction | [1] 78.0 |
| Subtotal | 249.0 |
| Reactor operation and evaluation: | |
| Operating expenses | 104.1 |
| Program Direction: | |
| Operating expenses | 9.7 |
| Total Naval reactors development [1] | 420.8 |

[1] Within the requested construction dollars, funds in the amount of $35 million have been previously authorized. Total authorization funding requested is $385.8 million.

These figures include $45 million ($5 million—operating $40 million—construction) for the second year of work on the Materials Facility (DOE construction project 82–N–111). These funds were formally included in the DOE budget request by amendment.

The Fiscal Year 1983 budget request of $421 million provides for a continuation of current programs. The increase of $62 million over fiscal year 1982 is primarily due to escalation, fabrication and testing of advanced core components, servicing and refueling of prototype reactor plants, and construction of the Materials Facility.

A discussion by budget category follows:

### I. PLANT DEVELOPMENT

The Plant Development effort is directed toward making significant improvements in plant reliability through development of improved reactor components and systems, alternate plant materials, and new water chemistry treatment methods. This effort is necessary as the long term reliability of operating plant components and systems is essential to meeting the Department of Defense policy of extending ship lifetimes.

Component and system development work begins with reactor plant arrangement studies to determine operational requirements and proceeds through design, testing, and operational conditions and new materials are incorporated along with features to improve performance and meet naval requirements. Mathematical models are then developed to assess component performance and to allow data to be obtained from simulated plant operation. Installation suitability and maintenance capabilities of the primary plant components and systems are then verified in full scale mockups. Finally, prototype components are fabricated and subjected to exhaustive testing and evaluation.

Extensive testing and analysis of candidate plant materials and water chemistries are carried out to develop alternate material heat treatment methods, new materials, water chemistries, and operating parameters for reactor plant applications. Materials and water chemistry testing is accomplished through accelerated tests followed by qualification in prototypic test conditions and environments.

This work includes fundamental metallurgical development, heat treatment, corrosion and mechanical property testing, and failure analysis to verify material performance characteristics prior to commitment for use in reactor plants. Also, new techniques for testing are evolved and applied to improve material and water chemistry performance analysis for use in ensuring proper control of reactor plant material performance.

As part of this effort, data is obtained from operating reactor plants to determine performance and possible problem areas. This data is incorporated in the developmental process. The Plant Development work is accomplished in two ongoing areas: Materials, Chemistry and Supporting Development, and Plant Technology.

In fiscal year 1983, Naval Reactors will continue Plant Dtvelopment efforts, including: developing alloys with both high and low strength characteristics for use with the Advanced Fleet Reactor; operating and maintaining plant and plant support systems and performing reactor plant nuclear, thermal, hydraulic, noise and vibration tests for the S8G prototype; performing plant analysis for the D2W prototype core; providing design and fluid systems analysis for continuing plant operations; providing design analysis for the backfit of an advanced reactor in the CGN 36 and 38 Class cruisers; and developing advanced design reactor plant equipment for application to naval nuclear reactor plants.

## II. REACTOR DEVELOPMENT

The Reactor Development effort is focused on developing advanced reactors as heat sources with improved power capabilities, increased endurance, and added reliability for nuclear propulsion applications with the ultimate objective of the program being to develop cores that will last the lifetime of the ship. The design and development of new and advanced reactors will incorporate the latest reactor concepts and technology.

The foremost developmental needs for reactor cores of increased endurance are the fuel and poison elements which must be capable of sustaining increased irradiation damage due to the longer operating life of long life cores. The advanced fuel and poison elements must meet exacting performance requirements with high integrity throughout the long lifetime of the core without inspection or maintenance. In parallel, development of advanced control rod materials and control concepts capable of controlling these highly loaded cores is necessary. The design and analysis of these advanced naval cores is highly demanding due to the need to correctly predict long term reactivity behavior and material response in core concepts optimized to overcome the extremely hostile operating environment.

The development effort includes the fabrication of prototype cores and components for installation, operation, and testing in prototype reactor plants to determine performance capability and reliability under actual plant conditions. Sophisticated process and inspection techniques are developed and tested for application in the manufacture of advanced naval cores. Expended cores are examined to determine long term nuclear, materials, and component behavior. Data obtained from these examinations is incorporated into current developmental efforts. Work is conducted in several major ongoing areas: Core Examination, Materials Development, Nuclear Design and Analysis, Reactor Process Development, and Reactor Technology.

During fiscal year 1983, work will progress in this area, including performing tests of fuel and poison elements, cladding corrosion specimens, and core structural materials for the Submarine Test Core (STC) and continuing manufacture of STC components. Advanced Fleet Reactor development will continue including carrying out nuclear, mechanical, and thermal/hydraulic design analyses; initiating element preproduction, fuel assembly and heat treatment process development; initiating qualification of the computer aided temography system for fuel element inspection; continuing design and fabrication of the closure head, instrumented control drive mechanisms, and core barrel; continuing irradiation testing; and manufacturing the engineering test cell.

Additional work in the Reactor Development area will include: performing physics analyses and periodic testing of the advanced submarine core; providing nuclear design lifetime studies for the D2W prototype core; continuing design analyses of the D2W core with an advanced fuel system; examining expended cores and fuel element irradiation test samples; and continuing development of the Modified Fuel Process. Efforts to evolve improved materials and new manufacturing processes, will include: performing irradiation testing and chemical analyses of materials; developing and testing advanced fuel and poisons; and developing and performance testing cladding and structural materials.

### CAPITAL EQUIPMENT

Capital Equipment funds are requested in fiscal year 1983 to support continuing research and development activities. Improved and replacement equipment, components, and systems will be procured as necessary to continue program efforts.

### CONSTRUCTION

Construction funds are requested in fiscal year 1983 to continue the Modifications and Additions to Prototype Facilities and the Materials Facility, and for an addition to the radioactive materials laboratory facility. An amendment to the DOE budget request has been approved to restore funds for the Materials Facility.

The prototype modification effort, which was fully authorized in fiscal year 1981, provides for modifying the engineered safety features of several prototype plants. The work primarily involves upgrading the emergency fluid and electrical supply system capabilties.

The Materials Facility will provide a second source of supply for naval nuclear fuel. Presently, there is only one supplier for the nuclear fuel used in the production of cores for the Navy's nuclear powered ships. Such dependence poses the risk of prolonged disruption in fuel supplies because of strikes, operations shutdowns, natural catastrophes, or other unanticipated problems. At present, there is no fuel inventory and no ability to provide additional fuel. A shutdown of the sole fuel supplier would affect operation of the core manufacturers within six months. The added capacity provided by this project will also allow flexibility to accommodate an expanded shipbuilding program.

Funds are also requested for the design of a shielded hot cell to be located in an extension of the radioactive materials laboratory at the Knolls Atomic Power Laboratory. The new shielded cell will provide needed additional testing and examination capacity for Naval Reactors' efforts in analyzing advanced fuel systems currently under development as well as continued evaluation of existing fuel systems.

## III. REACTOR OPERATION AND EVALUATION

Reactor Operation and Evaluation involves the operation of land based prototype nuclear propulsion plants and related servicing and evaluation functions. The purpose is to test complete developmental plants, including individual cores and components. The reason for this is that nuclear propulsion plants are required to operate at a high temperature under harsh conditions with minimum maintenance for many years. While accelerated tests are used as an aid to simulate and predict behavior, actual in-service operation is the only way to reliably determine performance and provide design confirmation. In order to fully test reactor components and systems, prototype plants are instrumented to provide test data under various operating conditions that could be encountered. Special tests are periodically conducted and the results are compared with predictions to improve the precision of reactor design methods.

Equipment and procedures are designed and developed to service reactor plants. Servicing work includes: maintenance, disassembly, fuel exchange and reassembly operations on prototype and shipboard reactors, examination of installed reactor components, and removal of reactor components for examination. Equipment and procedures developed for prototype operations are used to the maximum extent in preparing for the servicing and refueling of shipboard reactors. Operation and evaluation efforts will continue in three ongoing areas: Reactor Engineering and Analysis, Reactor Operation and Testing, and Reactor Servicing and Refueling.

Work in the reactor operation and evaluation area will continue throughout fiscal year 1983, including: continuing preparation of operating and testing procedures for the Submarine Test Core; performing safety analyses of the Advanced Fleet Reactor; designing a reactor servicing system for Advanced Fleet Reactor installation in a prototype plant; continuing operation of the prototype plants, including performing reactor plant nuclear, thermal, hydraulic, and mechanical tests, plant modifications, maintenance and training, and operating plant support systems; checking out equipment, completing training and performing the refueling of the S1C prototype; continuing preparations for the refueling and servicing of various prototypes; evaluating continued use of D2W prototype mechanical components beyond original nominal life; designing and procuring S8G prototype refueling equipment.

## IV. PROGRAM DIRECTION

The program direction funds provide for salaries, benefits, travel, and other expenses for 207 full time Federal employees at Naval Reactors, and its two field offices in Pittsburgh and Schenectady in support of the Naval Reactors Development and Water Cooled Breeder programs.

Naval Reactors maintains a minimal personnel level and has been able to operate with austere staffing through careful management of personnel to meet work requirements. Improvements in work force productivity have been achieved over the years by maximum use of available staff to carry out increasing workloads. This approach has resulted in limited changes in the personnel level.

Report NT-82-1
February 1982

# ENVIRONMENTAL MONITORING AND DISPOSAL OF RADIOACTIVE WASTES FROM U. S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES
1981

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# ABSTRACT

The environmental effect of disposal of radioactive wastes originating from U. S. Naval nuclear propulsion plants and their support facilities is assessed. The total gamma radioactivity in liquids, less tritium, discharged to all ports and harbors from the more than one hundred Naval nuclear-powered ships and supporting tenders, Naval bases and shipyards was less than 0.002 curie in 1981. The total tritium released to all ports and harbors was less than one curie in 1981. This report confirms that procedures used by the Navy to control releases of radioactivity from U. S. Naval nuclear-powered ships and their support facilities are effective in protecting the environment and the health and safety of the general public.

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## SUMMARY

The radioactivity in wastes discussed in this report originates in the pressurized water reactors of U. S. Naval nuclear-powered ships. As of the end of 1981, the U. S. Navy had 121 nuclear-powered submarines and twelve nuclear-powered surface ships in operation. Support facilities involved in construction, maintenance, overhaul and refueling of these nuclear propulsion plants include nine shipyards, fifteen tenders and three submarine bases. This report describes disposal of radioactive liquid wastes, transportation and disposal of solid wastes, and monitoring of the environment to determine the effect of radioactive releases, and updates reports on this subject issued by the Navy in references 1 through 16.* This report concludes that radioactivity associated with U. S. Naval nuclear-powered ships has had no significant or discernable effect on the quality of the environment. A summary of the radiological information supporting this conclusion follows:

From the start of the Naval nuclear propulsion program, the policy of the U. S. Navy has been to reduce to the minimum practicable the amounts of radioactivity released into harbors. Navy procedures to accomplish this have been reviewed with the U. S. Department of Energy, the U. S. Nuclear Regulatory Commission and the U. S. Environmental Protection Agency. The total gamma radioactivity released within twelve miles from shore from all U. S. Naval nuclear-powered ships and their support facilities in recent years is shown in Table 1; this includes all harbors both U. S. and foreign entered by these ships.

TABLE 1 RADIOACTIVE LIQUID WASTE RELEASED TO HARBORS FROM U. S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES

| Year | Number of Ships In Operation | Radioactivity-Curies (less tritium) |
|---|---|---|
| 1971 | 100 | less than 0.002 |
| 1972 | 104 | less than 0.002 |
| 1973 | 107 | less than 0.002 |
| 1974 | 111 | less than 0.002 |
| 1975 | 113 | less than 0.002 |
| 1976 | 115 | less than 0.002 |
| 1977 | 120 | less than 0.002 |
| 1978 | 124 | less than 0.002 |
| 1979 | 126 | less than 0.002 |
| 1980 | 126 | less than 0.002 |
| 1981 | 133 | less than 0.002 |

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*References are listed on page 32.

As a measure of the significance of these data, if one person were able to drink the entire amount of radioactivity discharged into any harbor in any of the last eleven years, he would not exceed the annual radiation exposure permitted for an individual worker by the U. S. Nuclear Regulatory Commission.

Environmental monitoring is conducted by the U. S. Navy in U. S. and foreign harbors frequented by the U. S. Naval nuclear-powered ships. This monitoring consists of analyzing harbor water, sediment and marine life samples for radioactivity associated with Naval nuclear propulsion plants, radiation monitoring around the perimeter of support facilities and effluent monitoring. Environmental samples from each of these harbors are also checked at least annually by a U. S. Department of Energy laboratory to ensure analytical procedures are correct and standardized. The U. S. Environmental Protection Agency has conducted independent surveys in U. S. harbors; results have been consistent with Navy results. These surveys have confirmed that U. S. Naval nuclear-powered ships and support facilities have had no significant effect on the radioactivity of the marine environment.

## RADIOACTIVE LIQUID WASTE PROCESSING AND CONTROL

### Policy and Procedures Minimizing Release of Radioactivity in Harbors

The policy of the U. S. Navy is to reduce to the minimum practicable the amounts of radioactivity released to the environment, particularly within twelve miles from shore including into harbors. This policy is consistent with applicable recommendations issued by the Federal Radiation Council (incorporated in Environmental Protection Agency in 1970), U. S. Nuclear Regulatory Commission, National Council on Radiation Protection and Measurements, International Commission on Radiological Protection, International Atomic Energy Agency, and National Academy of Sciences—National Research Council (references 17 through 25). Keeping releases small minimizes the radioactivity available to build up in the environment or to concentrate in marine life. To implement this policy of minimizing releases, the Navy has issued standard instructions defining the radioactive waste disposal limits and procedures to be used by U. S. Naval nuclear-powered ships and their support facilities. These instructions were reviewed by the U. S. Department of Energy, the U. S. Nuclear Regulatory Commission and the U. S. Environmental Protection Agency.

### Source of Radioactivity

In the shipboard reactors, pressurized water circulating through the reactor core picks up the heat of nuclear reaction. The reactor cooling water circulates through a closed piping system to heat exchangers which transfer the heat to water in a secondary steam system isolated from the primary cooling water. The steam is then used as the source of power for the propulsion plant as well as for auxiliary machinery. Releases from the shipboard reactors occur primarily when reactor coolant water expands as a result of being heated to operating temperature; this coolant passes through a purification system ion exchange resin bed prior to being transferred from the ship.

The principal source of radioactivity in liquid wastes is from trace amounts of corrosion and wear products from reactor plant metal surfaces in contact with reactor cooling water. Radionuclides with half-lives greater than one day in these corrosion and wear products include tungsten 187, chromium 51, hafnium 181, iron 59, iron 55, nickel 63, zirconium 95, tantalum 182, manganese 54, cobalt 58, and cobalt 60. The most predominant of these is cobalt 60, which has a 5.3 year half-life; cobalt 60 also has the most restrictive concentration limit in water as listed by organizations which set radiological standards in references 17, 18, and 19 for these corrosion and wear radionuclides. Therefore, radioactive waste disposal is conservatively controlled by assuming that all the long-lived radioactivity is cobalt 60.

## Radioactivity Removal From Liquid Wastes at Shore Facilities

Radioactive liquid wastes at shore facilities are collected in stainless steel tanks and processed through a processing system to remove most of the radioactivity (exclusive of tritium) prior to collection in a clean tank for reuse. Even after processing to approximately $10^{-8}$ microcuries of gamma radioactivity per milliliter, reactor coolant is reused rather than discharged. Figure 1 shows a simplified block diagram of the waste processing system which consists of particulate filters, activated carbon bed filters, mixed hydrogen hydroxyl resin and colloid removal resin beds. This type of processing system has been developed and used successfully to produce high quality water containing very low radioactivity levels.

## Liquid Waste Releases in Harbors

The total amounts of long-lived gamma radioactivity released into harbors and seas within twelve miles from shore have been less than 0.002 curie during each of the last eleven years. This total is for releases from U. S. Naval nuclear-powered ships and from the supporting shipyards, tenders and submarine bases, and at operating bases and home ports in the U. S. and overseas and all other U. S. and foreign ports which were visited by Naval nuclear-powered ships. This quantity is conservatively reported as if it consisted entirely of cobalt 60, which is the predominant long-lived gamma radionuclide and also has the most stringent concentration limits.

To put this small quantity of radioactivity into perspective, it is less than the quantity of naturally occurring radioactivity (reference 26) in the volume of saline harbor water occupied by a single nuclear-powered submarine.

Although volumes are of less significance than the amounts of radioactivity released, Table 1 of earlier reports has also shown that the total volume of liquids released within twelve miles from shore has been reduced from millions of gallons per year in the 1960's to less than 25 thousand gallons per year beginning in 1973. Thus, the Navy has achieved its policy of reducing releases of radioactive liquids in harbors to the minimum practicable amounts. Therefore, volumes have been deleted from this report.

## Short-Lived Radionuclides

Reactor coolant also contains short-lived radionuclides with half-lives of seconds to hours. Their highest concentrations in reactor coolant are from nitrogen 16 (7 second half-life), nitrogen 13 (10 minute half-life), fluorine 18 (1.8 hour half-life), argon 41 (1.8 hour half-life) and manganese 56 (2.6 hour half-life). Total short-lived radioactivity released in water in a year to any harbor has been less than 0.001 curie.

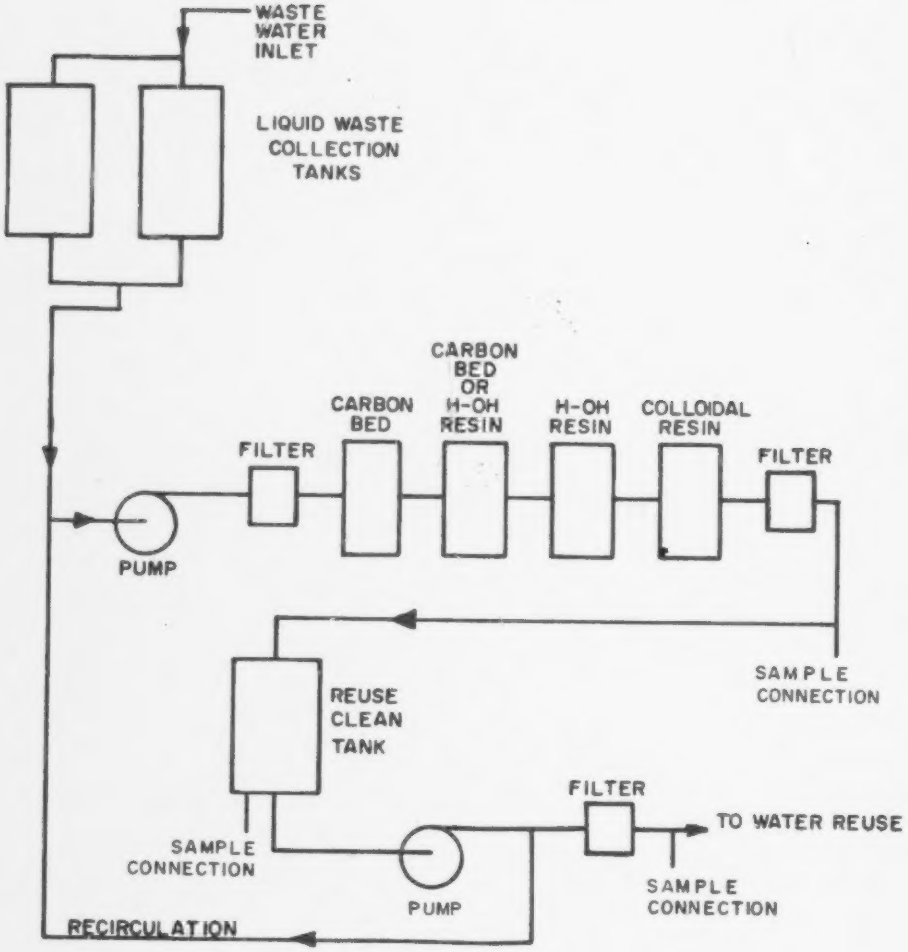
WASTE WATER INLET
LIQUID WASTE COLLECTION TANKS
CARBON BED OR H-OH RESIN
CARBON BED
H-OH RESIN
COLLOIDAL RESIN
FILTER
FILTER
PUMP
SAMPLE CONNECTION
REUSE CLEAN TANK
FILTER
TO WATER REUSE
SAMPLE CONNECTION
PUMP
SAMPLE CONNECTION
RECIRCULATION

FIGURE 1
SIMPLIFIED DIAGRAM OF WASTE PROCESSING SYSTEM

For the longest-lived of these, about one day after discharge from an operating reactor, the concentration is reduced to one thousandth of the initial concentration, and in about two days the concentration is reduced to one millionth. Therefore, since most of the water is transferred to shore facilities for processing and reuse rather than discharged, these short-lived radionuclides are not important for water disposal considerations.

### Fission Product Radionuclides

Fission products produced in the reactor are retained within the fuel elements. The fission gases krypton and xenon are also retained within the fuel elements. However, trace quantities of naturally occurring uranium impurities in reactor structural materials release small amounts of fission products to reactor coolant. The concentrations of fission products and the volumes of reactor coolant released are so low, however, that the total radioactivity attributed to long-lived fission product radionuclides, strontium 90 and cesium 137, in releases from U. S. Naval nuclear-powered ships and their support facilities has been less than 0.001 curie per year for all harbors combined. Fallout of these same fission products has often been more than this in one rainfall in a single harbor.

### Tritium

Small amounts of tritium are formed in reactor coolant systems as a result of neutron interaction with the approximately 0.015 percent of naturally occurring deuterium present in water, and other nuclear reactions. Although tritium has a 12 year half-life, the radiation produced is of such low energy that the radioactivity concentration guide issued by the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, the U. S. Nuclear Regulatory Commission and by other standard-setting organizations is one hundred times higher for tritium than for cobalt 60. This tritium is in the oxide form and chemically indistinguishable from water; therefore, it does not concentrate significantly in marine life or collect on sediment as do other radionuclides.

Tritium is naturally present in the environment because it is generated by cosmic radiation in the upper atmosphere. Reference 27 reports that the production rate from this source is about six million curies per year, which through rainfall causes a tritium inventory in the oceans of about one hundred million curies. Because of this naturally occurring tritium, much larger releases of tritium than are conceivable from Naval nuclear reactors would be required to make a measurable change in the background tritium concentration.

The total amount of tritium released during each of the last thirteen years from all U. S. Naval nuclear-powered ships and their supporting tenders, bases and shipyards has been less than 200 curies. Most of this has been into the ocean greater than twelve miles from shore. The total tritium released from the entire nuclear Navy is less than single electrical generating nuclear power stations typically release each year (reference 28). Total tritium released into harbors within twelve miles from shore was less than one curie in 1981. Such releases are too small to increase measurably the tritium concentration in the environment. Therefore, tritium has not been combined with the data on other radionuclides in other sections of this report.

## Carbon 14

Carbon 14 is also formed in small quantities in reactor coolant systems as a result of neutron interactions with nitrogen and oxygen. Carbon 14 decays with a half-life of 5730 years; however, only low energy beta radiation is emitted as a result of this decay process. As a result, the radioactivity concentration guide for carbon 14 in its chemical form in air issued by the International Commission on Radiological Protection, the National Council on Radiation Protection and Measurements, the U. S. Nuclear Regulatory Commission and by other standard-setting organizations is three thousand times higher than for cobalt 60.

Carbon 14 occurs naturally in the environment. It is generated from cosmic radiation interactions with nitrogen and oxygen in the upper atmosphere and oxidized to form carbon dioxide. Carbon 14 is chemically indistinguishable from other isotopes of carbon. The carbon dioxide diffuses and convects throughout the atmosphere and enters the earth's carbon cycle. Reference 29 states that the earth's carbon 14 inventory is estimated to be about three hundred and ten million curies. The total amount of carbon 14 released during each of the last thirteen years from the operation of all U. S. Naval nuclear-powered ships and their supporting tenders, bases and shipyards has been less than 100 curies, most of which is released into the atmosphere at sea beyond twelve miles from shore. The total carbon 14 radioactivity released in a year in any harbor has been less than 0.1 curie. Since the inventory of naturally occurring carbon 14 is so large, it is extremely unlikely that releases from Naval nuclear reactors could result in a measurable change in the background concentration of carbon 14. Therefore, carbon 14 has not been combined with the data on other radionuclides in other sections of this report.

## Liquid Waste Releases at Sea

Radioactive liquids incidental to the operation of the nuclear propulsion plants are released at sea under strict controls. These ocean releases are consistent with recommendations the Council on Environmental Quality made in 1970 to the President in reference 30, and consistent with the Marine Protection, Research and Sanctuaries Act, reference 31. Procedures and limits for ocean releases have been consistent with recommendations made by the National Academy of Sciences—National Research Council in reference 21 and by the International Atomic Energy Agency in reference 22. These releases have contained much less radioactivity than these reports considered would be acceptable. Total long-lived radioactivity excluding tritium, released farther than twelve miles from shore by U. S. Navy nuclear-powered ships and supporting tenders is shown in Table 2 for recent years. This is the total amount released from over 100 ships at different times of the year in the open sea at long distances from land in small incremental amounts, and under rapid dispersal conditions due to wave action. The quantity of radioactivity released to the open ocean in 1981 was 0.4 curie, which is less than the naturally occurring radioactivity in a cube of sea water approximately 100 yards on a side.

TABLE 2 TOTAL RADIOACTIVITY IN LIQUID WASTE RELEASED AT SEA ORIGINATING FROM U. S. NAVAL NUCLEAR-POWERED SHIPS

| | Radioactivity-Curies (less tritium) |
|---|---|
| 1974 | 0.4 |
| 1975 | 0.4 |
| 1976 | 0.4 |
| 1977 | 0.4 |
| 1978 | 0.4 |
| 1979 | 0.4 |
| 1980 | 0.4 |
| 1981 | 0.4 |

## Loss of USS THRESHER and USS SCORPION

Two U. S. Navy nuclear-powered submarines have been lost at sea in the Atlantic Ocean. The submarine THRESHER sank 10 April 1963, 100 miles from land in water 8,500 feet deep at latitude 41°45'N and longitude 65°00'W. The submarine SCORPION sank between 21 and 27 May 1968, 400 miles southwest of the Azores in more than 10,000 feet of water. The reactors used in all U. S. Naval submarines and surface ships are designed to minimize potential hazards to the environment even under the most severe casualty conditions such as actual sinking of the ship. First, the reactor core is so designed that it is physically impossible for it to explode like a bomb. Second, the reactor fuel elements are made of materials that are extremely corrosion resistant, even in sea water. The reactor core could remain submerged in sea water for decades without releases of fission products while the radioactivity decays, since the protective cladding on the fuel elements corrodes only a few millionths of an inch per year. Thus, in the event of a serious accident where the reactor is completely submerged in sea water, the fuel elements will remain intact for an indefinite period of time, and the radioactive material contained in these fuel elements should not be released. The maximum rate of release and dispersal of the radioactivity in the ocean, even if the protective cladding on the fuel were destroyed, would be so low as to be insignificant.

Radioactive material could be released from this type of reactor only if the fuel elements were actually to melt and, in addition, the high-strength, all-welded reactor system boundary were to rupture. The reactor's many protective devices and inherent self-regulating features are designed to prevent any melting of the fuel elements. Flooding of a reactor with sea water furnishes additional cooling for the fuel elements and so provides added protection against the release of radioactive fission products.

Radiation measurements, water samples, bottom sediment samples and debris collected from the area where THRESHER sank were analyzed for radioactivity shortly after the sinking and again in 1965 by various laboratories with highly sensitive equipment. Similarly, sea water and bottom sediment samples taken near SCORPION's hull were analyzed for radioactivity. None of these samples showed radioactivity above naturally occurring background levels, and none showed evidence of radioactivity released from either THRESHER or SCORPION.

In 1977, followup samples of water, sediment, marine life and debris were collected from the immediate THRESHER debris areas. In 1979, followup samples of water, sediment, marine life and debris were collected from the immediate SCORPION debris areas. None of these samples showed any evidence of release of radioactivity from the reactor fuel elements in either THRESHER or SCORPION. However, cobalt 60 released from both THRESHER and SCORPION coolant systems was detectable at low levels in sediment samples from localized areas which were not sampled during the original surveys. The cobalt 60 radioactivity in these sediment samples was small compared to naturally occurring radioactivity. Cobalt 60 was not detectable in the samples of water, marine life or debris. Thus, the THRESHER and SCORPION have not had a significant effect on the radioactivity in the environment.

## SOLID RADIOACTIVE WASTE DISPOSAL

During maintenance and overhaul operations, solid low-level radioactive wastes consisting of contaminated rags, plastic bags, paper, filters, ion exchange resin and scrap materials are collected by nuclear-powered ships and their support facilities. These low level radioactive materials from nuclear-powered ships are required to be strictly controlled to prevent loss. These controls include Naval accountability procedures which require serialized tagging and marking and signatures by radiologically trained personnel.

Solid radioactive waste materials are packaged in strong tight containers, shielded as necessary and shipped to burial sites licensed by the U. S. Nuclear Regulatory Commission or a State under agreement with the U. S. Nuclear Regulatory Commission. Solid radioactive materials from Naval nuclear-powered ships have not been dumped at sea since 1970 when the Navy issued procedures prohibiting sea disposal of solid radioactive materials. Shipyards and other shore facilities are not permitted to dispose of radioactive solid wastes by burial on their own sites.

Table 3 summarizes total radioactivity and volumes of radioactive solid waste disposal for the last five years. Table 3 includes all waste generated by U. S. Naval nuclear-powered ships and the listed support facilities since all radioactive solid waste generated by U. S. nuclear-powered ships is transferred to the listed facilities. The quantity of solid radioactive waste in any one year from a particular facility depends on the amount and type of support work performed that year. Table 3 does not include expended fuel or radioactive material associated with expended fuel since expended fuel is shipped from the refueling shipyard by the Department of Energy to its facilities in Idaho for processing in the same manner as other expended nuclear fuel.

Figure 2 shows that in the last ten years the total annual volume of solid low-level radioactive waste has been reduced by a factor of four despite increasing numbers of ships. Most of the volumes are generated during maintenance and overhaul operations in shipyards. This reduction has been accomplished simultaneously with reduction in personnel radiation exposure, as described in reference 32. This reduction has been accomplished by several techniques including a total containment concept for radiological work which minimizes the spread of radioactivity to non-radioactive materials, use of preplanning and mockups to minimize rework, reusing rather than disposing of tools and equipment, segregation of radioactive materials from other materials, use of liquid waste processing procedures which minimize depletion of processing media, and use of compaction equipment and efficient packaging to fully use space in disposal containers. Challenging goals are set by each shipyard to ensure continuing management attention to minimizing generation of waste in radiological work.

TABLE 3 RADIOACTIVE SOLID WASTE FROM U. S. NAVAL NUCLEAR-POWERED SHIPS AND THEIR SUPPORT FACILITIES FOR 1977 THROUGH 1981.

| Facility | 1977 Thousand Cubic Feet | 1977 Curies | 1978 Thousand Cubic Feet | 1978 Curies | 1979 Thousand Cubic Feet | 1979 Curies | 1980 Thousand Cubic Feet | 1980 Curies | 1981 Thousand Cubic Feet | 1981 Curies |
|---|---|---|---|---|---|---|---|---|---|---|
| Portsmouth, New Hampshire Naval Shipyard | 9 | 6 | 6 | 2 | 3 | 3 | 2 | 3 | 3 | 9 |
| Groton, New London, Conn. Electric Boat Division., Tender at State Pier, & Sub Base | 8 | 14 | 3 | <1 | 4 | <1 | 3 | <1 | 1 | <1 |
| Newport News, Virginia Newport News Shipbuilding | 2 | 5 | 3 | 15 | 2 | 4 | 1 | 1 | 4 | 12 |
| Norfolk, Virginia Naval Shipyard and Tenders | 6 | 1 | 4 | 2 | 2 | 5 | 2 | 4 | 5 | 7 |
| Charleston, South Carolina Naval Shipyard and Tenders | 7 | 13 | 7 | 17 | 3 | 5 | 3 | 3 | 2 | 3 |
| Pascagoula, Mississippi Ingalls Shipbuilding Div. | 3 | 10 | 2 | 1 | 1 | <1 | 1 | <1 | 3 | <1 |
| San Diego, California Tenders | 1 | 4 | 1 | <1 | 1 | <1 | 1 | <1 | 1 | <1 |
| Vallejo, California Mare Island Naval Shipyard | 7 | 27 | 11 | 18 | 2 | 22 | 6 | 36 | 2 | 16 |
| Bremerton, Washington Puget Sound Naval Shipyard & Sub Base | 6 | 10 | 7 | 5 | 7 | 3 | 5 | 21 | 7 | 11 |
| Pearl Harbor, Hawaii Naval Shipyard & Sub Base | 4 | 1 | 4 | 12 | 2 | 2 | 2 | 18 | 2 | 1 |
| TOTAL | 53 | 91 | 48 | 72 | 27 | 44 | 26 | 86 | 30 | 59 |

NOTES:
(1) This table includes all radioactive waste from tenders and nuclear-powered ships. This radioactivity is primarily cobalt 60. This radioactive waste is shipped to burial facilities licensed by the U. S. Nuclear Regulatory Commission or State.
(2) Volumes less than 500 cubic feet are reported <1 thousand and less than 0.5 curie is reported <1.
(3) The total volumes include 4000 cubic feet generated in 1979 and 1980 that were not shipped for disposal until 1981 due to temporary unavailability of burial facilities.

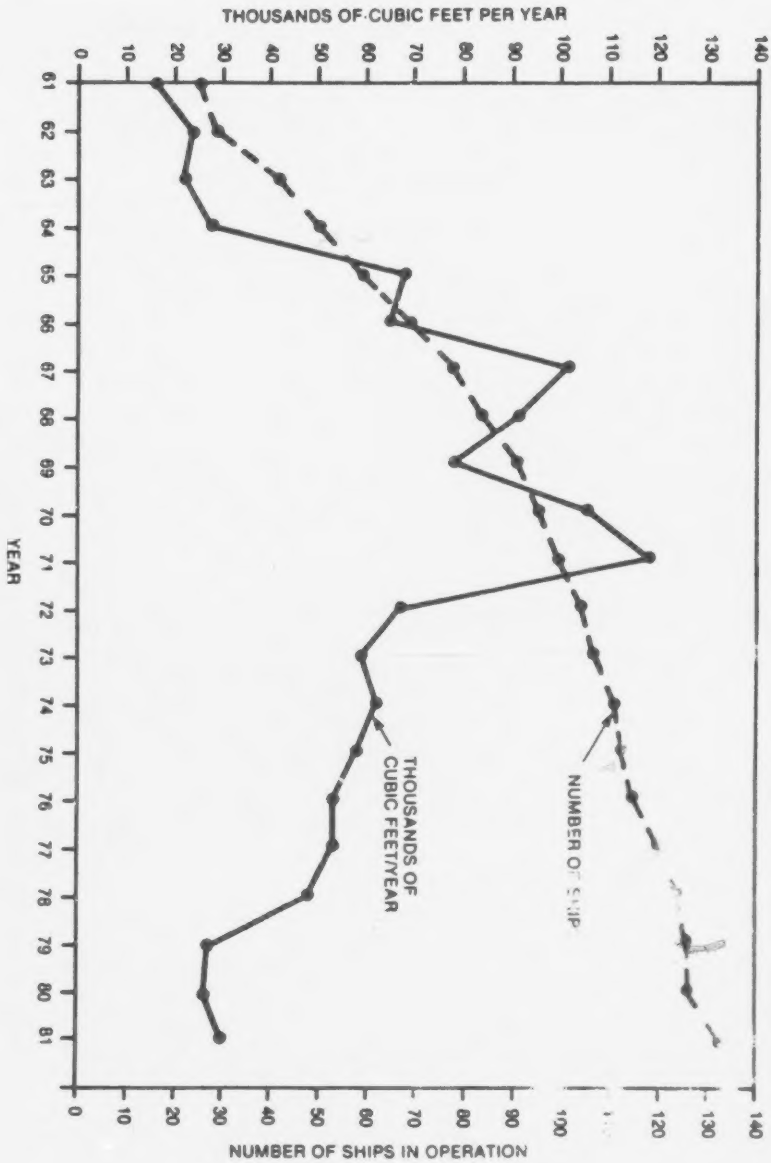

FIGURE 2
RADIOACTIVE SOLID WASTE DISPOSAL
VOLUMES IN THE NAVAL NUCLEAR
PROPULSION PROGRAM, 1961-1981

The annual volume for the entire Naval nuclear propulsion program could be contained in a cube measuring about ten yards on a side. The total annual volumes of solid radioactive waste from the Naval nuclear propulsion program listed in Table 3 are less than some individual electrical generating nuclear power stations generate annually (reference 28). The total annual volume is approximately 2 percent of the solid radioactive waste generated annually by all nuclear electric power reactors (reference 28) and less than 1 percent of the total volumes of radioactive solid waste buried in all U. S. commercial burial grounds each year (reference 33).

## TRANSPORTATION OF RADIOACTIVE MATERIAL

Shipments of radioactive materials in the Naval nuclear propulsion program are required to be made in accordance with regulations of the U. S. Department of Transportation, U. S. Department of Energy, and U. S. Nuclear Regulatory Commission. The purpose of these regulations is to ensure that shipments of radioactive material are adequately controlled to protect the environment and the health and safety of the general public. These regulations are applicable to all radioactive material shipments including waste. The shipments discussed herein cover areas in addition to waste for completeness.

The above regulations provide requirements for the container design, certification, and identification as applicable for the specific quantity, type and form of radioactivity being shipped. Naval shipping container design requirements invoke shielding and integrity specifications and meet all regulatory requirements. They provide for testing of container designs, training and qualification of workers who construct containers, and quality control inspections during fabrication to ensure the containers will meet their design requirements.

In addition to imposing requirements of Federal transportation regulations, the Navy has issued standard instructions to further control shipments of radioactivity associated with U. S. Naval nuclear propulsion plants. These standard instructions result in a quality assurance program which includes inspections and assessments by independent organizations and senior management. Organizations making shipments are required to prepare local procedures which require use of compliance checklists and management review to ensure compliance with applicable Department of Transportation, Navy, and burial ground requirements. Only specially trained, designated people, knowledgeable in shipping regulations, are permitted to authorize shipments of radioactive material.

Protective transportation service such as signature security service or sealed shipping vehicles are required for these shipments to ensure point-to-point control and traceability of each shipment from shipper to receiver. A readily accessible log of all shipments in transit is maintained to enable prompt identification and provide the basis for advice on the nature of the shipment. Return receipts are required to be made in writing by receivers to ensure that radioactive material has not been lost in shipment. Receipt inspection of containers of radioactive material and accompanying documents are required promptly after receipt to monitor compliance. Even minor discrepancies from detailed shipping regulations are required to be reported to the shipper so that correction can be made in future shipments. This is done to ensure compliance with shipping regulations.

Radioactive materials shipped in the Naval nuclear propulsion program include anticontamination clothing for laundry, small sealed sources used for calibrating radiation monitoring instruments, tools and equipment used for radioactive work, low-level radioactive waste, radioactive components and new and spent nuclear fuel. A total of approximately 1000 shipments are made annually by Naval nuclear-powered ships and their support facilities, which is a small part of the approximately two million shipments of radioactive materials made annually in the United States (Reference 34).

Nearly all radioactive shipments in the Naval nuclear propulsion program contain only low-level radioactivity classified under Department of Transportation regulations as low specific activity or limited quantity shipments. The predominant radionuclide associated with these shipments is cobalt 60 in the form of insoluble metallic oxide corrosion products attached to surfaces of materials inside shipping containers. Most low-level shipments are made by truck. Air transport is used no more than a few times per year for the Naval nuclear propulsion program. These air shipments involve only very low-level radioactivity and are not shipped on passenger planes.

Nearly one-quarter of the low-level radioactivity shipments are minute quantities in sealed instrument calibration check sources. These sources contain insignificant quantities of radioactivity which are comparable to the radioactivity in typical ionization type smoke detectors. Approximately 65 percent of the shipments are anticontamination clothing, equipment and tools. The anticontamination laundry involves shipments of special outer clothing potentially contaminated with low-levels of radioactivity while worn in controlled work areas. This laundry is shipped by Nuclear Regulatory Commission licensed contractors to their facilities for cleaning. On the average, one shipment of low-level radioactive waste per three months is made from each facility listed in Table 3.

The remaining few shipments are new and spent nuclear fuel and radioactive components associated with spent nuclear fuel and are shipped by the U. S. Department of Energy. Such shipments are made infrequently since U. S. Naval nuclear-powered ships need refueling infrequently. Spent nuclear fuel shipments are made to Department of Energy facilities for disposition. Measures are carried out to assist in safeguarding these shipments and assuring they reach their destination. Each spent fuel shipment is escorted by U. S. Government representatives and each shipping container is specifically designed to withstand extreme accident impacts, fire,or water immersion, and to prevent release of the material to the environment in the event of an accident. The cargo in the nuclear fuel and radioactive component shipments is non-explosive and non-flammable and, in addition, the radioactive material in the radioactive components is in an insoluble form that should not be dispersed even in the event of an accident.

Estimates of radiation exposure to transportation crews and the general public from shipments of radioactive materials in the Naval nuclear propulsion program have been made in a manner consistent with that employed by the U. S. Nuclear Regulatory Commission in reference 34. Based on comparisons of the types and numbers of radioactive shipments made, the total annual radiation exposure to all transportation crews for all shipments is estimated to be less than 3 man-rem. If one person were to receive all this exposure, he would not exceed the radiation exposure permitted for an individual worker by the U. S. Nuclear Regulatory Commission. The total estimated radiation exposure accumulated by the public along transportation routes is not more than a few times higher than the exposure to transportation workers. The maximum exposure to any individual member of the public would be far less than received from natural radiation.

Shipments of radioactive materials associated with Naval nuclear propulsion plants have not resulted in any measurable release of radioactivity to the environment. There have never been any significant accidents involving release of radioactive material during shipment since the Naval nuclear propulsion program began. In general, the few accidents that have occurred involved incidents such as broken truck axles or slight external damage to a shipping container with no release of radioactivity. In one incident a train collision resulted in minor denting of a new fuel shipping container with no loss of integrity of the container, no damage to the fuel and no release of radioactivity. In the only two instances that involved loss of contents, one quart containers holding samples were broken open in shipment. In one case this occurred when a cargo aircraft crashed. The other container was lost from a commercial ship. Both containers were recovered and there was no measurable radioactivity released since the original contents were less than one millionth of a curie, too small to be measurable in the environment.

The requirements of the Naval nuclear propulsion program specify that the carriers for all radioactive material shipments shall have accident plans which identify the actions to be taken in the event the transportation vehicle is involved in an accident. These plans provide for notification of civil authorities and the originating facility. The U. S. Navy would communicate with and cooperate fully with State radiological officials in the event of occurrences involving shipment of radioactive materials.

## ENVIRONMENTAL MONITORING

To provide additional assurance that procedures used by the U. S. Navy to control radioactivity are adequate to protect the environment, the Navy conducts environmental monitoring in harbors frequented by its nuclear-powered ships. Environmental monitoring surveys for radioactivity are periodically performed in harbors where U. S. Naval nuclear-powered ships are built or overhauled and where these ships have home ports or operating bases. Samples from each harbor monitored are also checked at least annually by a U. S. Department of Energy laboratory to ensure analytical procedures are correct and standardized. The Department of Energy laboratory results have been consistent with shipyard and operating base results.

### Navy Environmental Monitoring Program

The current Navy environmental monitoring program consists of analyzing samples of harbor water and sediment, supplemented by shoreline surveys, posted dosimeters and effluent monitoring. Sampling harbor water and sediment each quarter year is emphasized since these materials would be the most likely affected by releases of radioactivity. Marine life samples have also been collected from some harbors.

Five water samples are taken in each harbor once each quarter year in areas where nuclear-powered ships berth and from upstream and downstream locations. These samples are analyzed for gross gamma radioactivity and for cobalt 60 content. A solid state lithium-drifted germanium detector with a multichannel analyzer is used to measure gross gamma radioactivity in an energy range from 0.1 MeV to 2.1 MeV expressed in terms of cobalt 60 equivalent and to analyze the resulting gamma data for the presence of cobalt 60. Procedures for analysis will detect cobalt 60 if its concentration exceeds the U. S. Environmental Protection Agency drinking water limits of reference 25. No cobalt 60 has been detected in any of the water samples from all harbors monitored.

A radiological laboratory of the Environmental Protection Agency has analyzed samples from harbors to identify radionuclides present in sediment. These analyses showed cobalt 60 was the predominant radionuclide added to sediment from Naval nuclear reactor operations. Therefore, Navy monitoring procedures require collecting in each harbor approximately 20 to 120 sediment samples once each quarter year for cobalt 60 and gross gamma analyses. Locations and numbers of sediment samples for a particular harbor depend on the size of the harbor and the number and separation of locations where nuclear-powered ships berth. Sampling points are selected to form a pattern around ship berthing locations and to provide points in areas away from these berthing locations. The sampling locations are selected individually for each harbor considering characteristics of the harbor. Sediment samples are collected using the dredge shown in Figure 3. The dredge samples a surface area of 36 square inches and has been modified to collect only the top one-half to one inch of sediment. The top layer was selected because it should be more mobile and more accessible to marine life than deeper layers. After the dredge is lowered to the harbor bottom, the messenger weight is lowered on the support line from the surface and causes the spring-loaded jaws on the dredge to close and trap the sediment. The samples are placed directly into a one quart Marinelli container for analysis. Each sediment sample is analyzed for gamma radioactivity in the container in which it is collected using the lithium-drifted germanium detector with a multichannel analyzer. The sediment samples are not dried prior to analysis but excess water is drained off. Gross gamma radioactivity in an energy range from 0.1 MeV to 2.1 MeV is expressed in terms of equivalent cobalt 60 and the resulting gamma data is analyzed for the presence of cobalt 60 radioactivity. Results of the sediment samples from harbors monitored by the Navy in the U. S. and possessions for 1981 are summarized in Table 4.

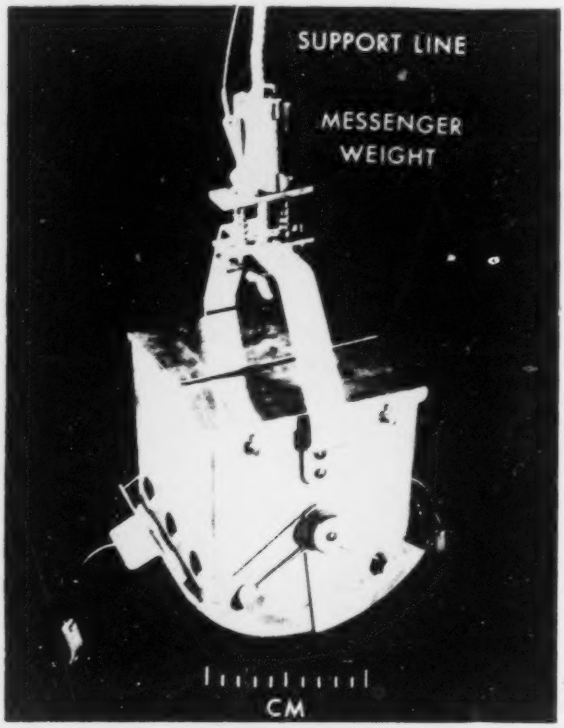

FIGURE 3

DREDGE FOR SAMPLING HARBOR SEDIMENT

## TABLE 4 SUMMARY OF 1981 SURVEYS FOR COBALT 60 IN BOTTOM SEDIMENT OF U. S. HARBORS WHERE U. S. NAVAL NUCLEAR-POWERED SHIPS HAVE BEEN REGULARLY BASED, OVERHAULED OR BUILT

| | Number of Samples with Cobalt 60 | | | Total Bottom Area with Cobalt 60 over $3 \times 10^{-6}\mu Ci/gm$** (Square Kilometers) | Estimated Total*** Cobalt 60 in Top Layer of Sediment (Curies) |
|---|---|---|---|---|---|
| | less than $3x10^{-6}\mu Ci/gm$* | 3 to $30x 10^{-6}\mu Ci/gm$ | Greater than $30x 10^{-6}\mu Ci/gm$ | | |
| Portsmouth, New Hampshire<br>Naval Shipyard | 176 | 0 | 0 | 0 | ND |
| Groton, New London, Conn.<br>Electric Boat Division, State Pier and Submarine Base | 530 | 2 | 0 | 0.001 | 0.01 |
| Newport News, Virginia<br>Newport News Shipbuilding | 152 | 0 | 0 | 0 | ND |
| Norfolk, Virginia<br>Naval Shipyard and Base | 256 | 0 | 0 | 0 | ND |
| Charleston, South Carolina<br>Naval Shipyard and Bases | 206 | 0 | 0 | 0 | ND |
| St. Marys, Georgia | 92 | 0 | 0 | 0 | ND |
| Pascagoula, Mississippi<br>Ingalls Shipbuilding Division | 80 | 0 | 0 | 0 | ND |
| San Diego, California<br>Navy Piers | 247 | 0 | 0 | 0 | ND |
| Vallejo, California<br>Mare Island Naval Shipyard | 227 | 0 | 0 | 0 | ND |
| Bremerton, Washington<br>Naval Shipyard and Base | 316 | 0 | 0 | 0 | ND |
| Pearl Harbor, Hawaii<br>Naval Shipyard and Sub Base | 184 | 0 | 0 | 0 | ND |
| Apra Harbor, Guam | 128 | 0 | 0 | 0 | ND |
| Port Canaveral, Florida | 80 | 0 | 0 | 0 | ND |

NOTE: *Minimum detectable radioactivity is approximately 0.2 millionths of a microcurie per gram.
$1\mu Ci = 1 \times 10^{-6} Ci$

**One square kilometer is approximately equal to 0.4 square mile. Areas with cobalt 60 over $3 \times 10^{-6}\mu Ci/gm$ were in immediate vicinity of piers used for berthing nuclear-powered ships.

***Where total cobalt 60 in the surface sediment layer is less than 0.01 curie, ND is reported. Samples more than one foot deep from several harbors show that total cobalt 60 present may be two to five times that measured in the surface layer.

****Since nuclear-powered ships are no longer based at Long Beach, California, environmental monitoring is no longer conducted in that harbor.

Evaluation of the data summarized in Table 4 shows that low-level cobalt 60 radioactivity in harbor bottom sediment is detected around a few operating base and shipyard piers where nuclear-powered ship maintenance and overhauls have been conducted over a period of several years. The radioactivity detected is from operations in the early 1960's since releases such as shown earlier in Table 1 are too small to be detectable in the harbors. Cobalt 60 is not detectable above background levels in general harbor bottom areas away from these piers. Maximum total radioactivity observed in a U. S. harbor is less than 0.05 curie of cobalt 60. This radioactivity is small compared to background; based on the typical concentrations of naturally occurring radioactivity such as potassium 40, radium, uranium and thorium which are described in reference 26 for marine sediment, the natural radioactivity in the sediment of a typical harbor amounts to hundreds of curies. Comparison to previous environmental monitoring data in references 1 through 16 shows that these environmental cobalt 60 levels have been steadily decreasing.

The first data column in Table 4 includes all samples with less than 3 millionths of a microcurie of cobalt 60 per gram of sediment. Most of the sediment samples did not contain detectable cobalt 60 and are tabulated in this range. In this range cobalt 60 is comparable to the levels of naturally occurring radioactivity such as potassium, radium, uranium and thorium. Cobalt 60 in sediment in this low range may also be detectable as a result of world wide dispersion from atmospheric nuclear weapons testing.

The value of 30 millionths of a microcurie per gram was selected for the top of the second range of data in Table 4. A measure of the significance of this range is that if all a person's food were to contain cobalt 60 in this range of radioactivity throughout the year, he would not exceed radiation exposure levels permitted in references 17, 18 and 19 for members of the general public. Only two of the sediment samples are in this second range, and none of the samples exceeded this range in 1981. Data on uptake of this cobalt 60 by marine life obtained to date show that in the salt water harbor bottom environments, no significant buildup of cobalt 60 occurs in marine life. An EPA evaluation in reference 35 shows that the cobalt 60 from Naval nuclear propulsion plants is in the form of metallic corrosion product particles which do not appear to be concentrated in the food chain. Because of the nature of the radioactivity and the low concentrations noted in Table 4, extensive monitoring of radioactivity in marine life has not been necessary as part of routine environmental monitoring programs in these harbors.

In addition to Navy analysis of environmental samples, at least two sediment samples from each harbor monitored have been sent each year to a U. S. Department of Energy laboratory, as a check of Navy results. This Department of Energy laboratory provides a further check on the quality of environmental sample analyses by participating in the quality control programs sponsored by the Department of Energy and the Environmental Protection Agency.

The check samples were analyzed for gamma radionuclides in a manner similar to Navy procedures but with greater sensitivity. Figure 4 depicts the gamma spectra for two such samples. Both spectra show the presence of abundant naturally occurring radionuclides which contribute to measured radioactivity even if cobalt 60 were not present. The upper spectrum is for a sample to which cobalt 60 has been added to a concentration of approximately 3 millionths of a microcurie per gram and shows easily recognizable energy peaks due to the presence of this small concentration of cobalt 60. The lower spectrum depicts the appearance of most of the sediment samples in the first column in Table 4.

In addition to the extensive quarterly monitoring of harbor water and sediment, selected samples of marine life such as mollusks, crustaceans and marine plants have been collected in 1981 from most harbors monitored. Marine life samples are also analyzed using a lithium-drifted germanium detector with a multi-channel analyzer. No buildup of cobalt 60 associated with U. S. Naval nuclear-powered ships has been detected in these samples of marine life.

For comparison, references 36 and 37 contain evaluations by laboratories of the Environmental Protection Agency and of the Department of Energy of the effects on the environment from the accumulation near points of discharge of radionuclides from several nuclear facilities. The referenced reports conclude for these other facilities that radioactivity levels much greater than shown in Table 4 have caused no significant radiation exposure to the general public.

In all monitored harbors, twice per year shoreline areas uncovered at low tide are surveyed for radiation levels with sensitive scintillation detectors to determine if any radioactivity from bottom sediment washed ashore. All results were the same as background radiation levels in these regions, approximately 0.01 millirem per hour. Thus, there is no evidence in these ports that these areas are being affected by nuclear-powered ship operations.

Ambient radiation levels are measured using sensitive thermoluminescent dosimeters continuously posted at locations outside the boundaries of areas where radioactive work is performed. These dosimeters are also posted at locations remote from support facilities to measure background radiation from natural radioactivity. Results of dosimeters posted at support facilities between radiologically controlled areas and the general public are compared with dosimeters posted at remote background locations up to several miles away. These results showed that radiation exposure to the general public from radioactive work on Naval nuclear propulsion plants has not increased above that received from natural background radiation.

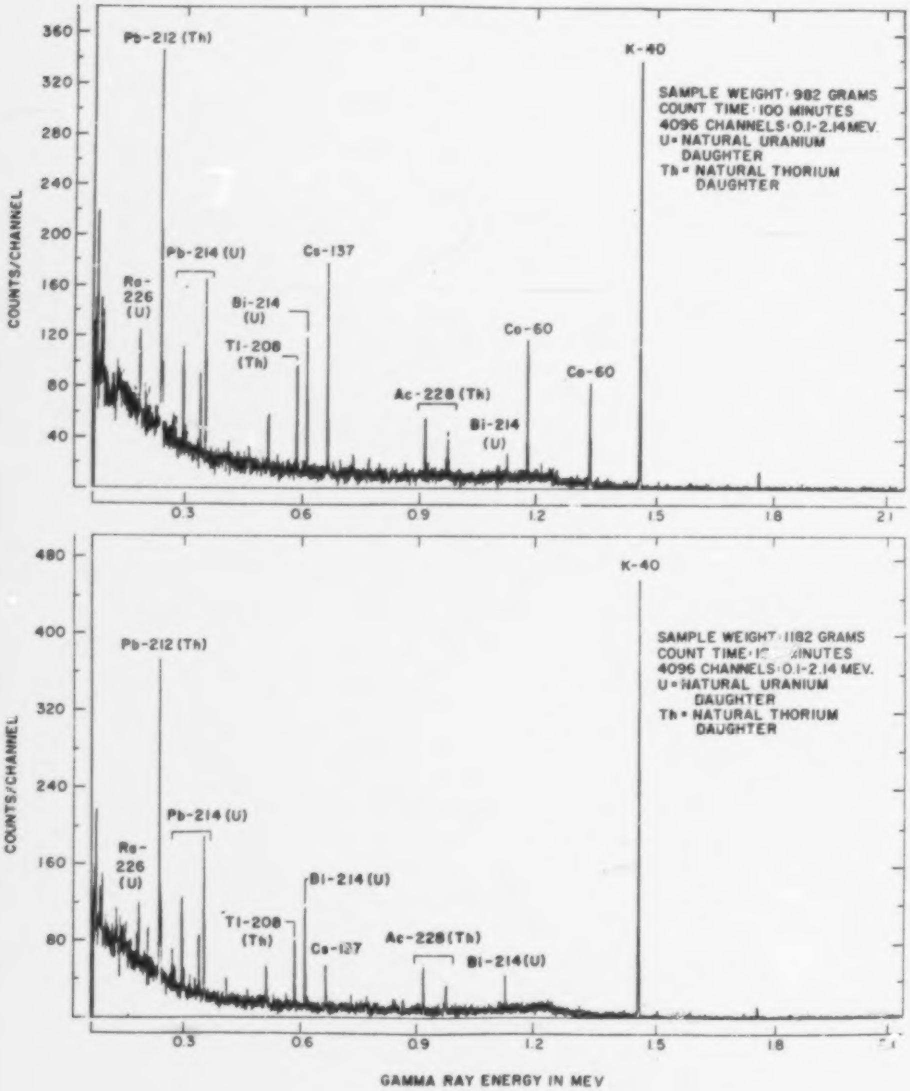

FIGURE 4 GAMMA SPECTRA OF HARBOR BOTTOM SEDIMENT SAMPLES WITH LITHIUM-DRIFTED GERMANIUM DETECTOR

Naval nuclear reactors and their support facilities are designed to ensure there are no significant discharges of radioactivity in airborne exhausts. Radiological controls are exercised in support facilities to preclude exposure to working personnel to airborne radioactivity exceeding limits for the general population specified in reference 17. These controls include a total containment concept for radioactive materials and provide a barrier to prevent significant radioactivity from becoming airborne. Further, all air exhausted from these facilities is passed through high efficiency particulate air filters and monitored during discharge. Comparision of sensitive airborne radioactivity measurements in shipyards demonstrates that air exhausted from facilities actually contained a smaller amount of radioactivity than this same air contained when it was drawn from the environment into the facilities. There were no discharges of airborne radioactivity above concentrations normally present in the atmosphere.

## ENVIRONMENTAL PATHWAYS ANALYSIS

Results of monitoring of environmental samples described above have shown that environmental radioactivity levels have not been changed appreciably and therefore radiation exposure to the public from operations of nuclear-powered ships and their support facilities is too low to measure. Nevertheless, a detailed analysis has been performed to provide a quantitative estimate of the radiation exposure to which any member of the general public might be exposed as a result of radioactivity in liquid and airborne effluents.

This analysis has been performed in a conservative manner which ensures that the estimated exposure is higher than any actual exposure would be. For example, the sites chosen for analysis were shipyards since the amount of radiological work at these facilities is considerably higher than at other types of support facilities. Quantities of radioactivity from shipyard releases used in this analysis are higher than have been measured from any shipyard in the last five years. Values of environmental parameters including meteorological conditions and radionuclide concentration factors have been chosen to provide conservative results. In addition, the analysis assumes the individual receiving the maximum exposure is located right at the site boundary. Thus, the actual exposures to members of the public are expected to be lower than the results of this analysis.

The environmental pathways which were considered are depicted in Figure 5, which is based on reference 19. The hypothetical releases assumed are listed in Table 5. Table 6 shows the assumed usage parameters which are based on reference 38. Concentration factors for radionuclides in the marine environment were assumed as published in reference 39 and are also in Table 6. The pathways analysis, including meteorology, population distribution, and radiological exposure rates was performed in a manner consistent with that employed by the U. S. Nuclear Regulatory Commission in reference 38.

Results of the analysis are summarized in Tables 7 and 8. Table 7 compares the estimated maximum exposure to a member of the public with guidelines of the Nuclear Regulatory Commission, although these guidelines are not applicable to nuclear-powered ships and their support facilities. These numerical guidelines on calculated radiation exposures have been issued by the Nuclear Regulatory Commission in reference 24 for implementing the concept that radioactivity in effluents from light water nuclear electric power reactors should be limited to amounts and quantities as low as reasonably achievable. These numerical guidelines of the NRC are consistent with environmental standards for the uranium nuclear fuel cycle issued by the Environmental Protection Agency in reference 40 Table 8 presents the estimated total whole body radiation exposure to the total population within 50 miles from the assumed radioactivity releases compared with the radiation exposure received by the same population from natural background radioactivity, as reported in references 23, 29 and 41. As shown in Tables 7 and 8, conservative estimates of the exposures to members of the public from the Naval nuclear propulsion program are far less than either the EPA standards, the guidelines of the Nuclear Regulatory Commission or the exposure from natural background radioactivity.

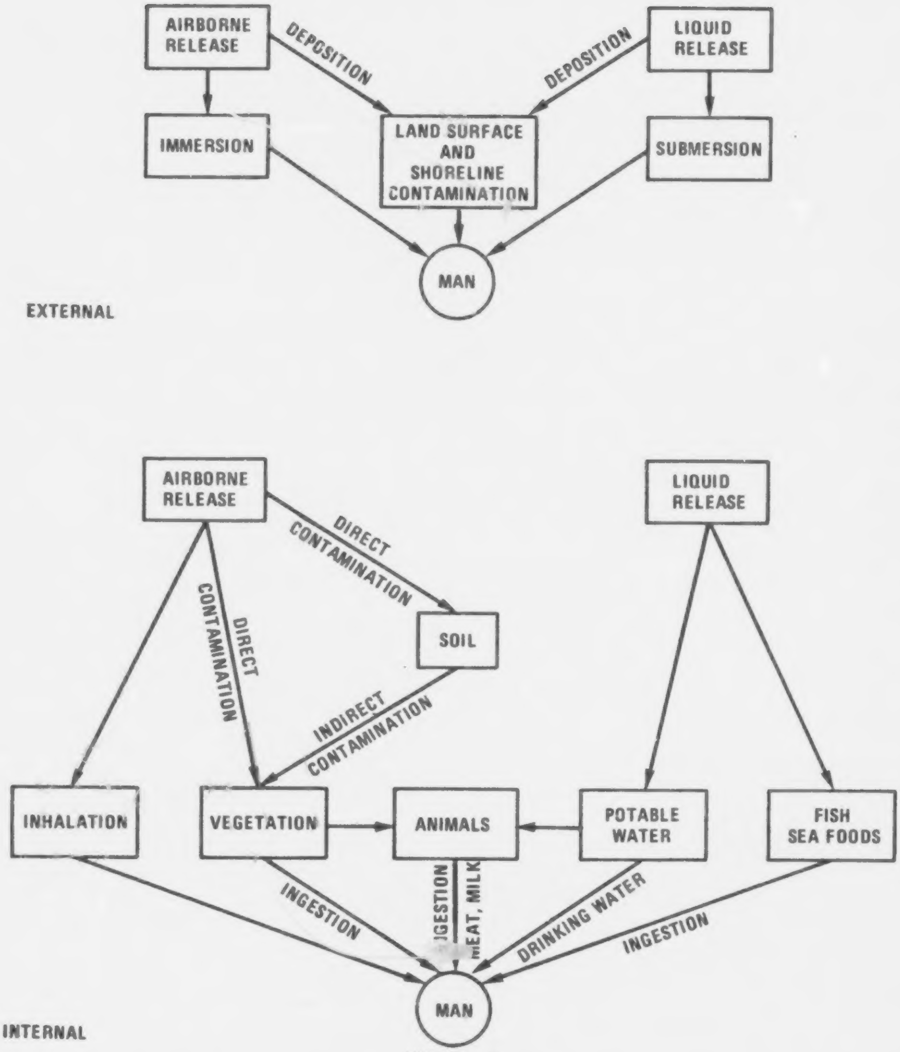
AIRBORNE RELEASE
DEPOSITION
DEPOSITION
LIQUID RELEASE
IMMERSION
LAND SURFACE AND SHORELINE CONTAMINATION
SUBMERSION
MAN
EXTERNAL
AIRBORNE RELEASE
DIRECT CONTAMINATION
LIQUID RELEASE
DIRECT CONTAMINATION
SOIL
INDIRECT CONTAMINATION
INHALATION
VEGETATION
ANIMALS
POTABLE WATER
FISH SEA FOODS
INGESTION
INGESTION
MEAT, MILK
DRINKING WATER
INGESTION
MAN
INTERNAL

FIGURE 5

PATHWAYS FOR EXTERNAL AND INTERNAL EXPOSURE OF MAN FROM AIRBORNE AND LIQUID RELEASES OF RADIOACTIVE EFFLUENTS

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TABLE 5 RADIONUCLIDE RELEASES ASSUMED FOR ENVIRONMENTAL PATHWAYS ANALYSIS

| | Assumed Annual Release, Curie | |
|---|---|---|
| Radionuclide | Liquid Release | Airborne Release |
| Cobalt 60 | 0.001 | 0.001 |
| Tritium | 0.100 | 0.001 |
| Carbon 14 | * | 0.100 |
| Krypton 83m | * | 0.020 |
| Krypton 85m | * | 0.024 |
| Krypton 85 | * | 0.001 |
| Krypton 87 | * | 0.050 |
| Krypton 88 | * | 0.020 |
| Xenon 131m | * | 0.005 |
| Xenon 133m | * | 0.010 |
| Xenon 133 | * | 0.210 |
| Xenon 135 | * | 0.250 |
| Argon 41 | * | 0.410 |

*These gaseous radionuclides are released into the air, not into water.

TABLE 6 ENVIRONMENTAL EXPOSURE TIMES, CONSUMPTION AND CONCENTRATION PARAMETERS ASSUMED FOR ENVIRONMENTAL PATHWAYS ANALYSIS

| Pathway Parameter* | Assumed Parameter Value | |
|---|---|---|
| | For Highest Individual | For Average Individual |
| Fraction of Year Occupancy | | |
| For Air Immersion | 1 | 1 |
| For Land Deposition | 1 | 1 |
| Along Shoreline | .05 | .0005 |
| Swimming | .01 | .0001 |
| Boating | .01 | .0001 |
| Food Consumption | | |
| Leafy vegetables, Kg/year | 72 | 18 |
| Water, liters/year | 730 | 180 |
| Fish,** Kg/year | 18 | 2.3 |
| Mollusks,** Kg/year | 9 | .25 |
| Crustacea,** Kg/year | 9 | .90 |
| Sediment, Kg/year | 1 | .10 |

* Refer to Figure 5

** Cobalt 60 was assumed to concentrate from sea water to the edible flesh of fish, mollusks, and crustacea by factors as follows: fish, 650; mollusks, 170; crustacea, 1700, based on reference 39.

TABLE 7 ESTIMATED MAXIMUM RADIATION EXPOSURE TO AN INDIVIDUAL FOR ASSUMED LIQUID AND AIRBORNE RADIOACTIVITY RELEASES FROM SHIPYARDS ENGAGED IN NAVAL NUCLEAR PROPULSION WORK

| | Maximum Exposure To An Individual | |
|---|---|---|
| | NRC Guideline millirem/year | Estimated Value millirem/year |
| From Radionuclides In Liquid Releases | 5 whole body, or any organ | less than 1 |
| From Gaseous Radionuclides In Airborne Releases | 5 whole body, or 15 skin | less than 1 |
| From Other Radionuclides In Airborne Releases | 15 any organ | less than 1 |

TABLE 8 ESTIMATED TOTAL WHOLE BODY RADIATION EXPOSURE TO GENERAL PUBLIC WITHIN 50 MILES FOR ASSUMED LIQUID AND AIRBORNE RADIOACTIVITY RELEASES FROM SHIPYARDS ENGAGED IN NAVAL NUCLEAR PROPULSION WORK

| Exposure Due to Natural Background Radiation | Exposure Due to Assumed Radioactive Releases |
|---|---|
| Approximately 100,000 man rem per year | less than 1 man rem per year |

## AUDITS AND REVIEWS

The requirements and procedures for control of radioactive waste are important parts of the training programs for everyone involved with radioactivity in the Naval nuclear propulsion program. Such training is part of the initial qualification of shipyard workers and of Naval personnel assigned to ships and bases, and is required to be repeated regularly. Emphasis on this training is part of the concept that radiological control personnel alone cannot cause radiological work to be well performed; production and operations personnel and all levels of management are required to be involved in the control of radioactivity.

Checks and balances of several kinds are also set up to help ensure control of radioactivity. First, written procedures exist which require verbatim compliance. Radiological control personnel monitor various steps in radioactive waste processing. In each shipyard an independent organization, separate from the radiological control organization, audits all aspects of radioactive waste processing. Audits are performed by representatives from Naval Reactors headquarters who are assigned full time at each shipyard. Radiological control personnel from headquarters also conduct periodic inspections of each shipyard. In addition, shipyards have made detailed assessments of the environmental effects of shipyard operations and have published reports on the results of these assessments. Similarly, there are multiple levels of audits and inspections for the other Navy shore facilities, tenders, and nuclear-powered ships and for other radiologically controlled functions such as transportation. Even the smallest audit findings are followed up to ensure proper recovery and permanent corrective actions are taken and to help minimize the potential for future deficiencies.

The policy of the Navy is to provide for close cooperation and effective communication with state radiological officials involving occurrences that might cause concern because of radiological effects outside the ships or shore facilities. The Navy has reviewed radioactive waste disposal, radiological environmental monitoring, transportation and other radiological matters with state radiological officials in the states where Navy nuclear-powered ships are based or overhauled. Although there were no occurrences in 1981 which resulted in radiological effects to the public outside these facilities, states were notified when inquiries showed public interest in the possibility that such events had occurred. The Navy has encouraged states to conduct independent radiological environmental monitoring in harbors where Naval nuclear-powered ships are based or overhauled; the results of monitoring by states have been consistent with Navy results.

The U. S. Environmental Protection Agency (EPA) has conducted detailed reviews of the Navy's procedures for controlling radioactive waste and for radiological environmental monitoring. An EPA laboratory has conducted detailed environmental surveys of selected U. S. harbors (references 35, 42, 43, 44, 45, 46). This laboratory has performed these surveys in the harbors at Charleston, South Carolina; Pearl Harbor, Hawaii; San Diego, California; Vallejo, California; New London, Connecticut; Newport News, Virginia; Norfolk, Virginia; Bremerton, Washington; and Kittery, Maine—Portsmouth, New Hampshire. EPA results have been consistent with Navy results. In the latest such EPA survey conducted in 1977 at the Portsmouth Naval Shipyard, EPA analyzed harbor water, sediment, marine life and air for radioactivity. No radioactivity from shipyard operations was detected.

## CONCLUSIONS

1. The total gamma radioactivity in liquids, less tritium, released into all ports and harbors from the U. S. Naval nuclear propulsion program was less than 0.002 curie in 1981. The total tritium released into all ports and harbors was less than one curie in 1981.

2. No increase of radioactivity above normal background levels has been detected in harbor water where U. S. Naval nuclear-powered ships are based, overhauled, or constructed.

3. Liquid wastes from U. S. Naval nuclear-powered ships and support facilities have not caused a measurable increase in the general background radioactivity of the environment.

4. Low-level cobalt 60 radioactivity in harbor bottom sediment is detectable around a few operating base and shipyard piers from low level liquid releases in the 1960's. Cobalt 60 is not detectable above background levels in general harbor bottom areas away from these piers. Maximum total radioactivity observed in a U. S. harbor of less than 0.05 curie of cobalt 60 is small compared to the naturally occurring radioactivity. Comparison to previous environmental data summarized in references 1 through 16 shows that these environmental cobalt 60 levels are continuing to decrease.

5. Conservative estimates of radiation exposures to members of the public from the Naval nuclear propulsion program are far less than either the Environmental Protection Agency environmental standards, the guidelines of the Nuclear Regulatory Commission or the exposure from natural background radioactivity.

6. Procedures used by the Navy to control discharges of radioactivity from U. S. Naval nuclear-powered ships and their support facilities have been effective in protecting the environment and the health and safety of the general public. Independent radiological environmental monitoring performed by the U. S. Environmental Protection Agency and states have confirmed the adequacy of these procedures.

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(6) -(14) U. S. Navy Reports—"Environmental Monitoring and Disposal of Radioactive Wastes from U. S. Naval Nuclear-Powered Ships and Their Support Facilities" M. E. Miles et al, for calendar years 1970 through 1978 published with the following numbers and dates: NT-71-1, May 1971; NT-72-1, September 1972; NT-73-1, September 1973; NT-74-1, October 1974; NT-75-1, May 1975; NT-76-1, August 1976; NT-77-1, June 1977; NT-78-1, February 1978; NT-79-1, January 1979.

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## APPENDIX
## ENVIRONMENTAL MONITORING SURVEY CHARTS

Environmental monitoring survey charts for harbors monitored for radioactivity associated with U. S. Naval nuclear-powered ships in the U. S. and possessions during 1981 are listed below and included in this appendix. The sampling locations for harbor water and harbor sediment are shown. In addition, shoreline survey areas and the locations of posted dosimetry devices are shown on the figures.

| Figure No. | Location |
|---|---|
| | California |
| 1 | U. S. Naval Air Station, Alameda |
| 2 | Hunters Point Shipyard, San Francisco |
| 3 | Mare Island Naval Shipyard, Vallejo |
| 4 | San Diego Harbor |
| 5 | San Diego Harbor, Ballast Point Area |
| | Connecticut |
| | Electric Boat Division, Groton |
| 7 | U. S. Naval Submarine Support Facility, New London Harbor |
| 8 | State Pier Area, New London |
| | Florida |
| 9 | Port Canaveral |
| | Georgia |
| 10 | U. S. Naval Submarine Support Facility, Kings Bay, St. Marys |
| | Guam |
| 11 | Apra Harbor |
| | Hawaii |
| 12 | Pearl Harbor Area |
| 13 | Pearl Harbor Naval Shipyard |
| 14 | U. S. Naval Submarine Base, Pearl Harbor |
| | Mississippi |
| 15 | Ingalls Shipbuilding Division, Pascagoula |
| | New Hampshire/Maine |
| 16 | Portsmouth Naval Shipyard |

South Carolina

17 U. S. Naval Station and Naval Shipyard, Charleston
18 U. S. Naval Weapons Station, Charleston

Virginia

19 Newport News Shipbuilding and Dry Dock Co., Newport News
20 Norfolk Naval Shipyard, Portsmouth
21 U. S. Naval Station Norfolk, Destroyer and Submarine Piers
22 Norfolk— Portsmouth Virginia Area

Washington

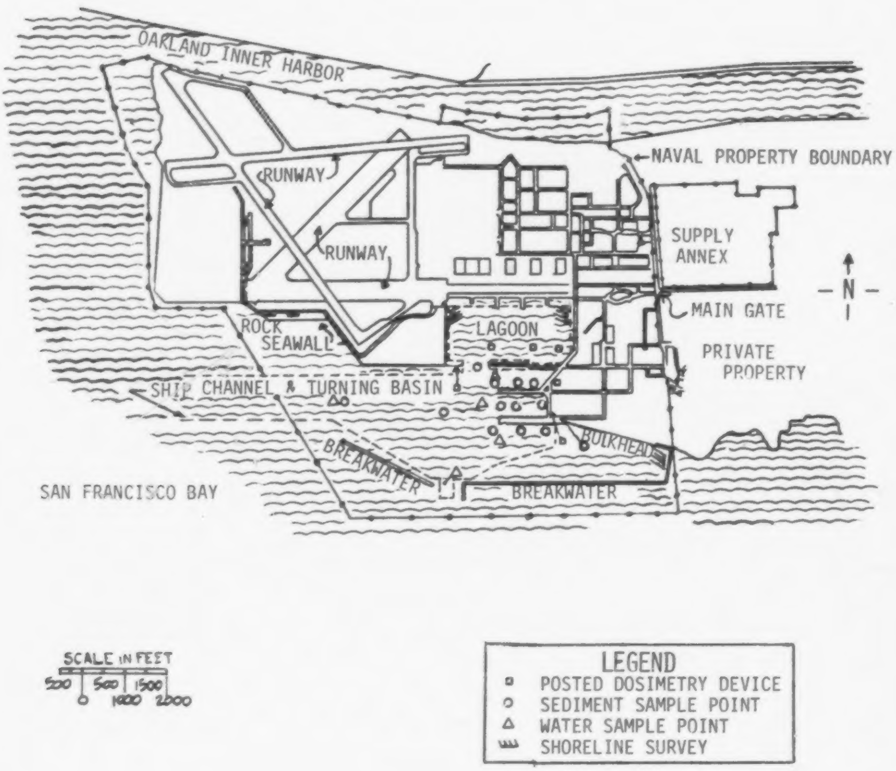
23 Puget Sound Naval Shipyard
24 Bangor/Hood Canal

FIGURE 1

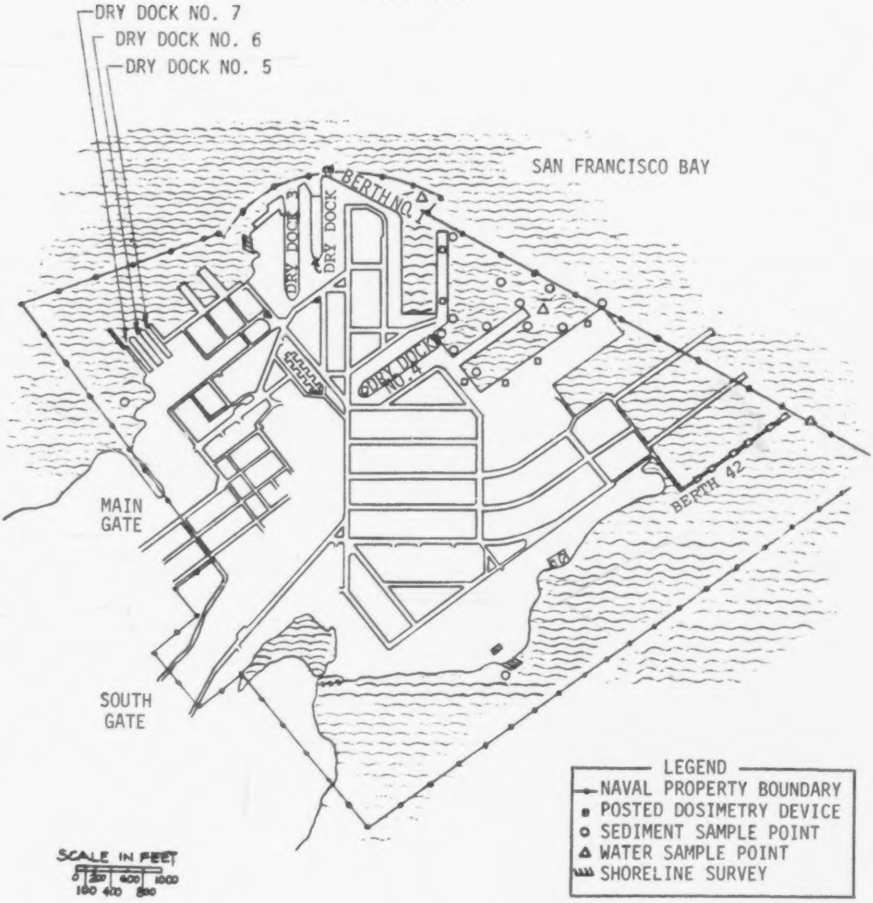
ENVIRONMENTAL MONITORING LOCATIONS

AT THE U. S. NAVAL AIR STATION

ALAMEDA, CALIFORNIA

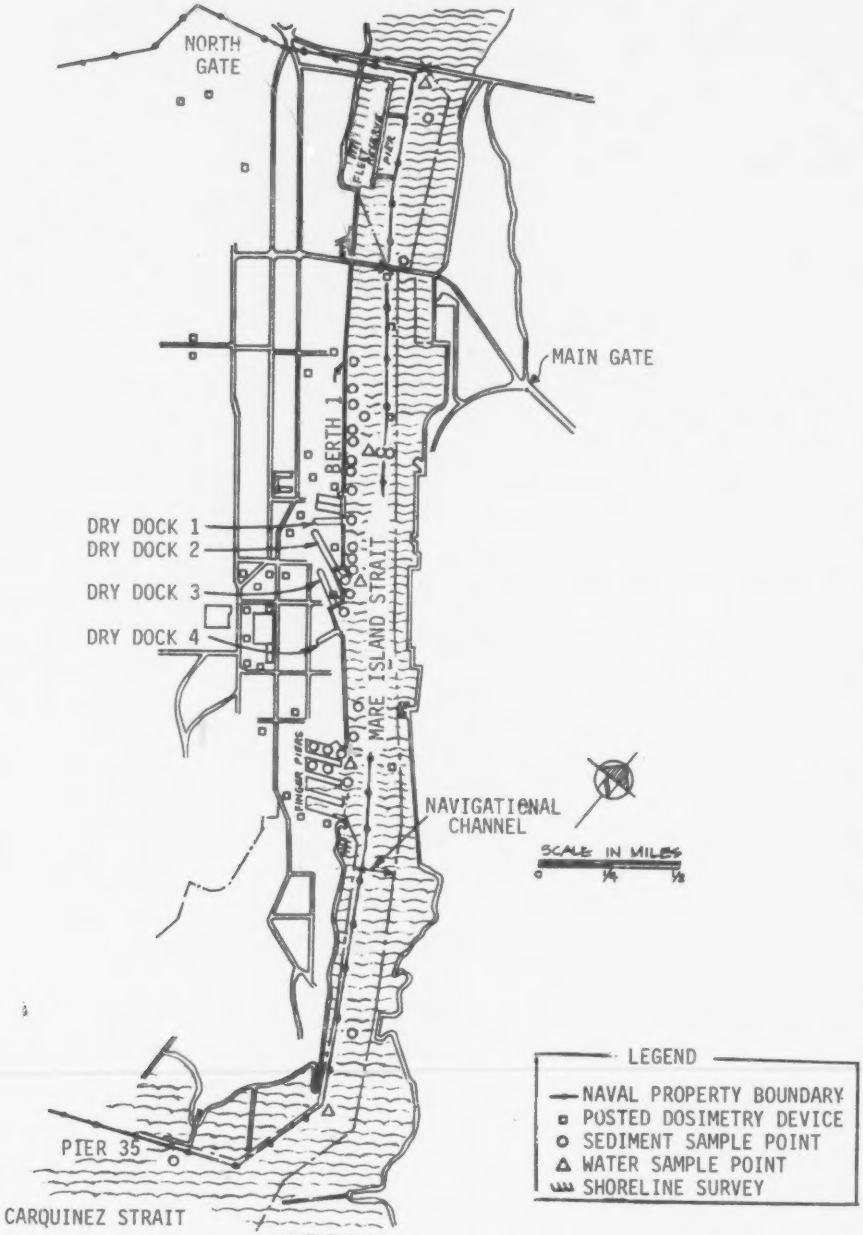

OAKLAND INNER HARBOR
NAVAL PROPERTY BOUNDARY
RUNWAY
RUNWAY
SUPPLY ANNEX
N
MAIN GATE
PRIVATE PROPERTY
LAGOON
ROCK SEAWALL
SHIP CHANNEL & TURNING BASIN
BULKHEAD
BREAKWATER
BREAKWATER
SAN FRANCISCO BAY
SCALE IN FEET
500
500
1500
0
1000
2000
LEGEND
POSTED DOSIMETRY DEVICE
SEDIMENT SAMPLE POINT
WATER SAMPLE POINT
SHORELINE SURVEY

ENVIRONMENTAL MONITORING LOCATIONS AT THE
HUNTERS POINT SHIPYARD
SAN FRANCISCO, CALIFORNIA
FIGURE 2


DRY DOCK NO. 7
DRY DOCK NO. 6
DRY DOCK NO. 5
SAN FRANCISCO BAY
BERTH NO. 1
DRY DOCK 3
DRY DOCK
DRY DOCK NO. 4
BERTH 42
MAIN GATE
SOUTH GATE
LEGEND
NAVAL PROPERTY BOUNDARY
■ POSTED DOSIMETRY DEVICE
○ SEDIMENT SAMPLE POINT
△ WATER SAMPLE POINT
SHORELINE SURVEY
SCALE IN FEET
0 200 600 1000
100 400 800

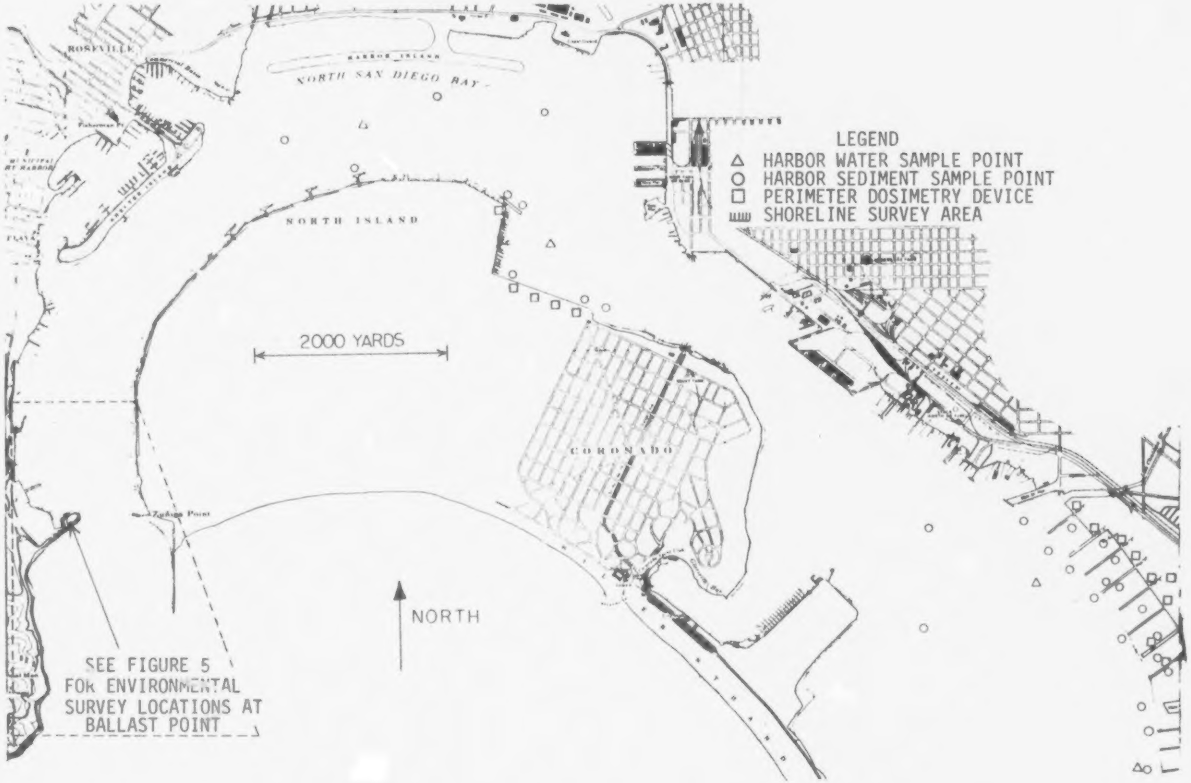
ENVIRONMENTAL MONITORING LOCATIONS AT THE
MARE ISLAND NAVAL SHIPYARD
VALLEJO, CALIFORNIA

FIGURE 3


NORTH GATE
FLEET RESERVE PIER
MAIN GATE
BERTH 1
DRY DOCK 1
DRY DOCK 2
DRY DOCK 3
DRY DOCK 4
MARE ISLAND STRAIT
FINGER PIERS
NAVIGATIONAL CHANNEL
N
SCALE IN MILES
0
1/4
1/2
PIER 35
CARQUINEZ STRAIT
LEGEND
NAVAL PROPERTY BOUNDARY
POSTED DOSIMETRY DEVICE
SEDIMENT SAMPLE POINT
WATER SAMPLE POINT
SHORELINE SURVEY

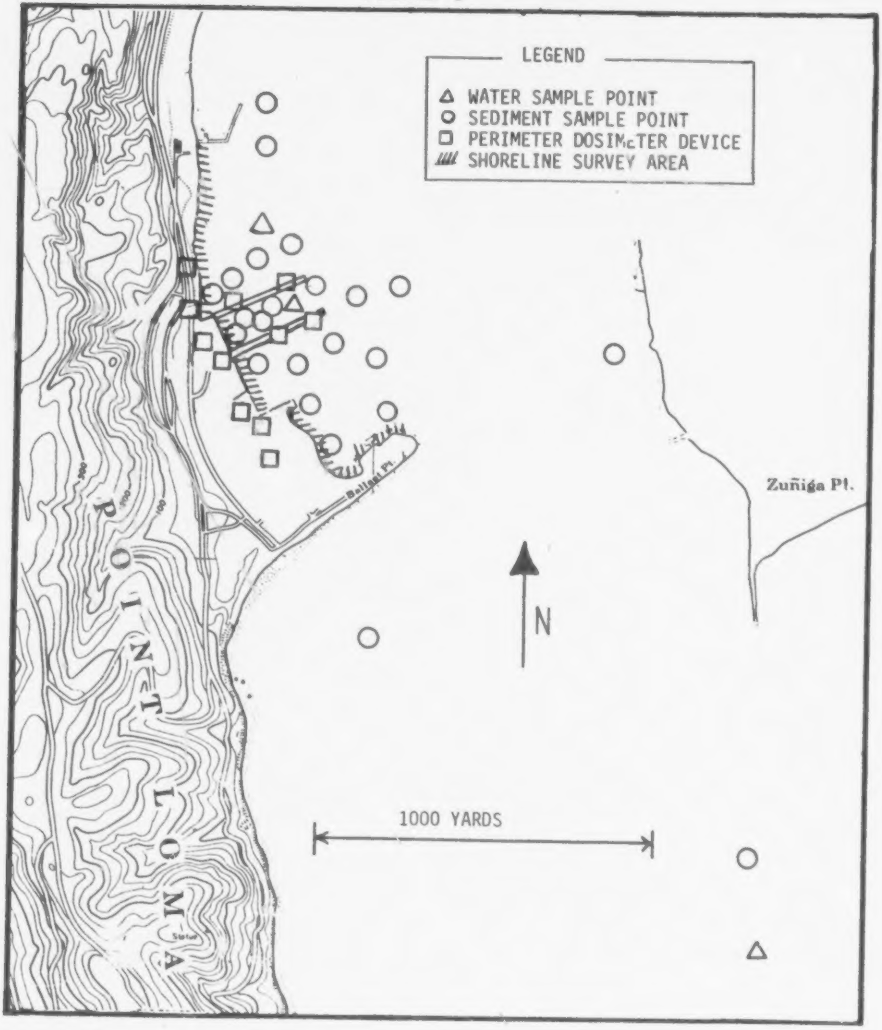
ENVIRONMENTAL MONITORING LOCATIONS AT SAN DIEGO BAY, CALIFORNIA

FIGURE 4

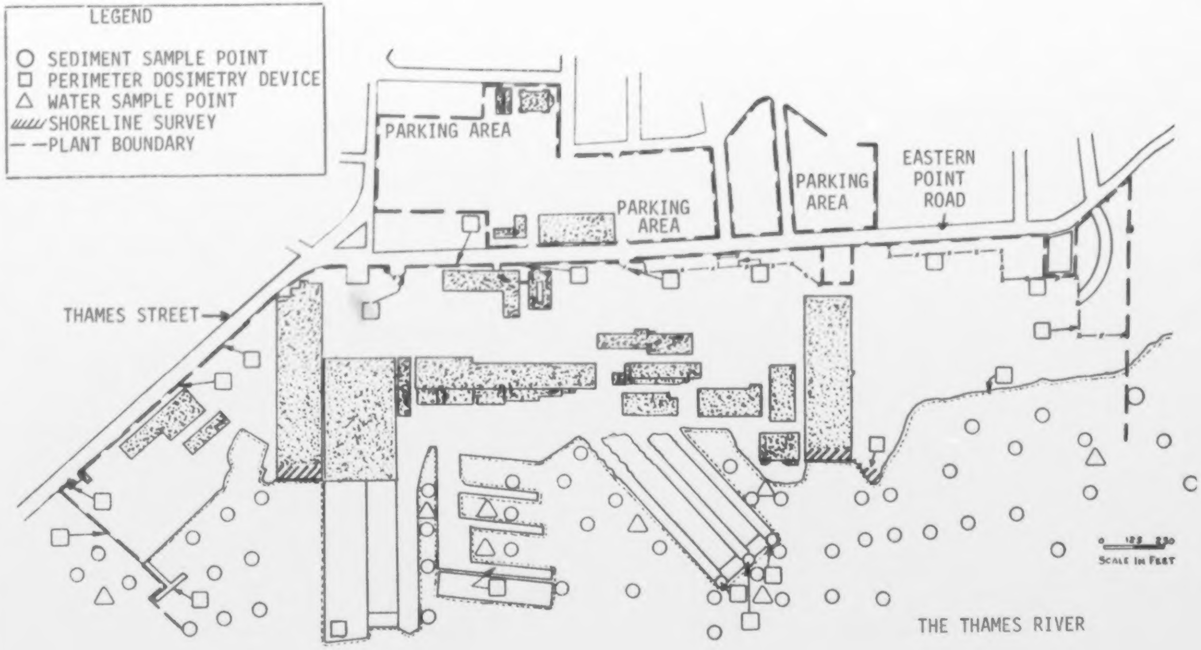

LEGEND
△ HARBOR WATER SAMPLE POINT
○ HARBOR SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
SHORELINE SURVEY AREA
ROSEVILLE
HARBOR ISLAND
NORTH SAN DIEGO BAY
NORTH ISLAND
CORONADO
Zuniga Point
2000 YARDS
NORTH
SEE FIGURE 5
FOR ENVIRONMENTAL
SURVEY LOCATIONS AT
BALLAST POINT

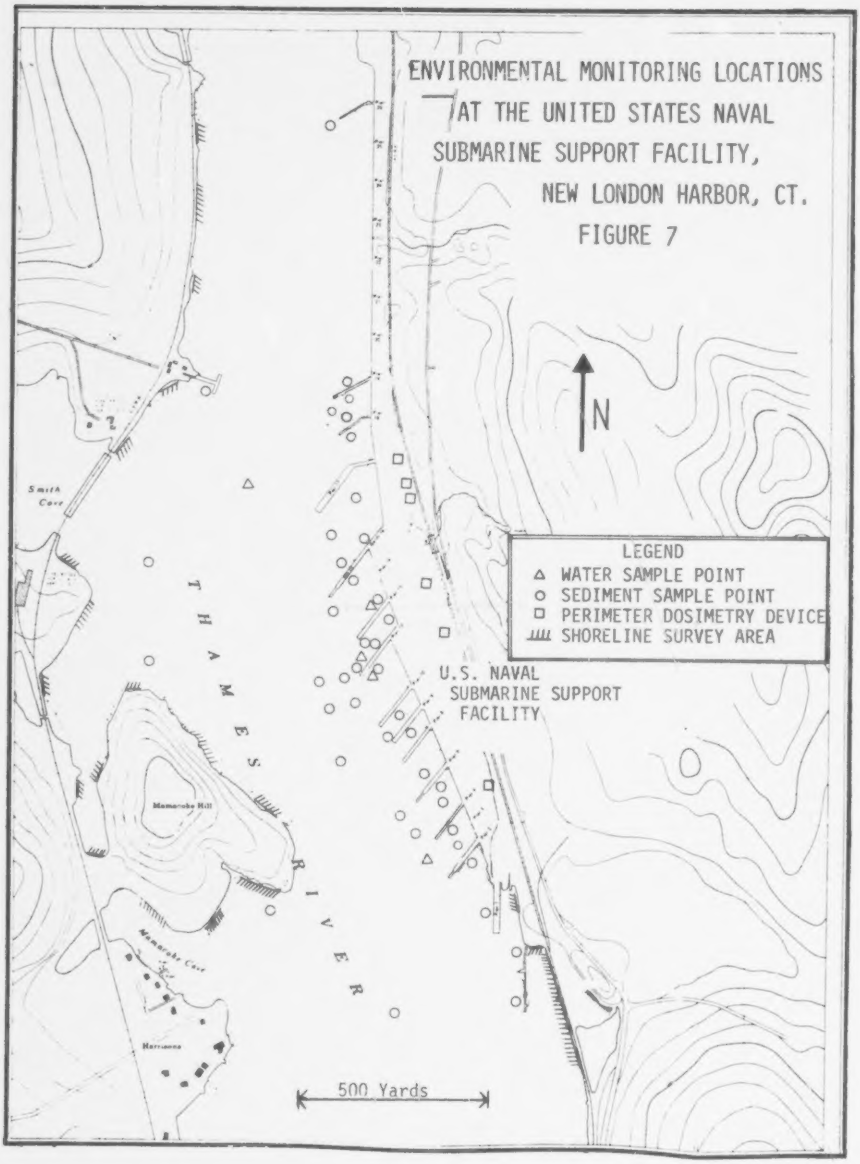
ENVIRONMENTAL MONITORING LOCATIONS AT
BALLAST POINT, SAN DIEGO HARBOR

FIGURE 5


LEGEND
△ WATER SAMPLE POINT
○ SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETER DEVICE
//// SHORELINE SURVEY AREA
Zuñiga Pt.
Ballast Pt.
POINT LOMA
N
1000 YARDS

ENVIRONMENTAL MONITORING LOCATIONS
AT GENERAL DYNAMICS/ELECTRIC BOAT
GROTON, CT.
FIGURE 6


LEGEND
○ SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
△ WATER SAMPLE POINT
▨ SHORELINE SURVEY
— — PLANT BOUNDARY
PARKING AREA
PARKING AREA
PARKING AREA
EASTERN POINT ROAD
THAMES STREET
0 125 250
SCALE IN FEET
THE THAMES RIVER



ENVIRONMENTAL MONITORING LOCATIONS AT THE UNITED STATES NAVAL SUBMARINE SUPPORT FACILITY, NEW LONDON HARBOR, CT.

FIGURE 7

N
LEGEND
△ WATER SAMPLE POINT
○ SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
ШШ SHORELINE SURVEY AREA
U.S. NAVAL SUBMARINE SUPPORT FACILITY
THAMES RIVER
Smith Cove
Mamacoke Hill
Mamacoke Cove
Harrisons
500 Yards

ENVIRONMENTAL MONITORING LOCATIONS
AT STATE PIER AREA, NEW LONDON, CT

FIGURE 8

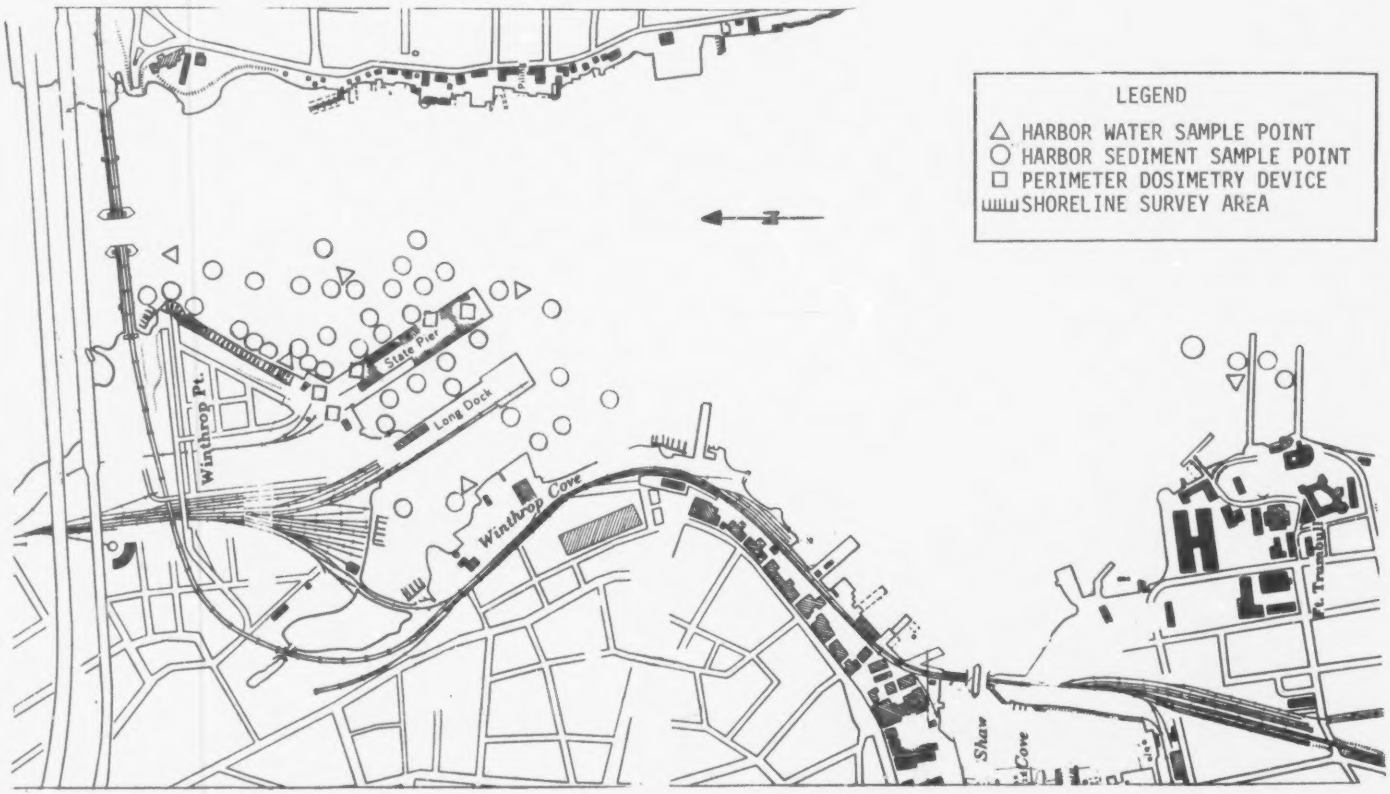
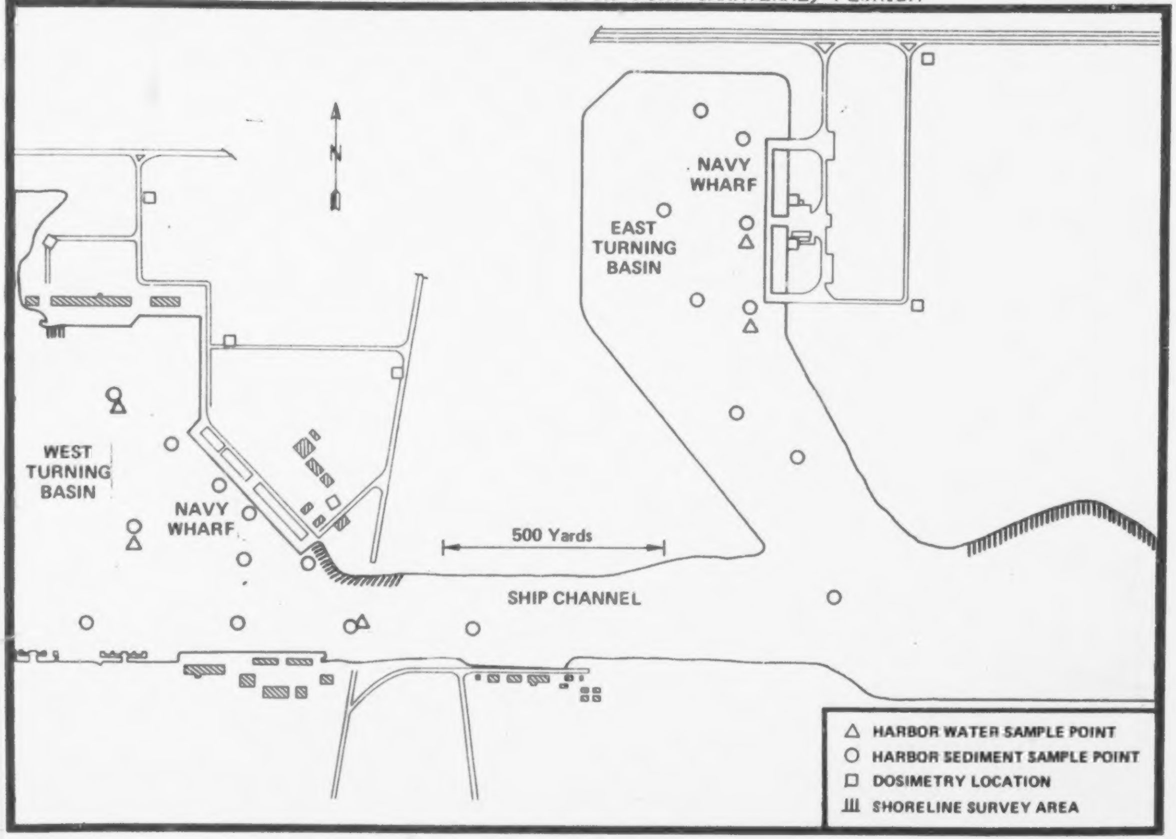
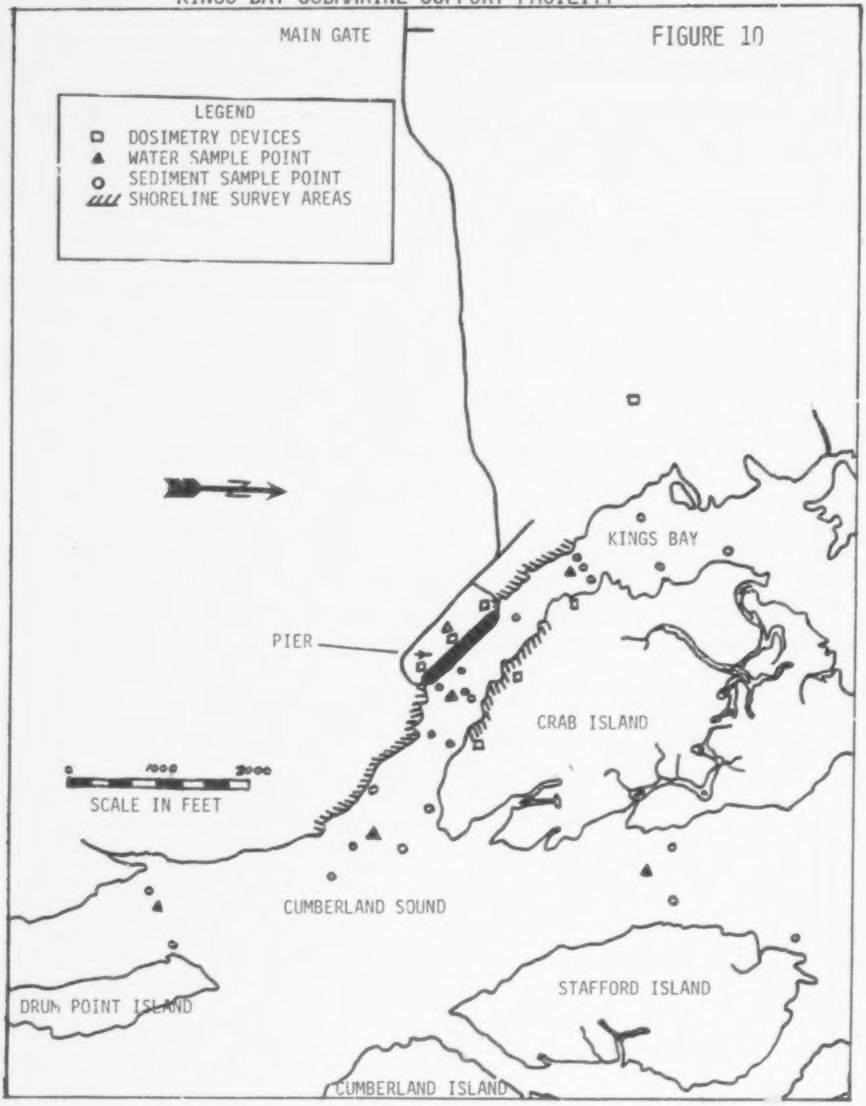

LEGEND
△ HARBOR WATER SAMPLE POINT
○ HARBOR SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
ШШ SHORELINE SURVEY AREA
N
State Pier
Long Dock
Winthrop Pt.
Winthrop Cove
Shaw Cove
Ft. Trumbull

FIGURE 9. ENVIRONMENTAL MONITORING LOCATIONS AT PORT CANAVERAL, FLORIDA


N
NAVY WHARF
EAST TURNING BASIN
WEST TURNING BASIN
NAVY WHARF
500 Yards
SHIP CHANNEL
△ HARBOR WATER SAMPLE POINT
○ HARBOR SEDIMENT SAMPLE POINT
□ DOSIMETRY LOCATION
Ш SHORELINE SURVEY AREA

ENVIRONMENTAL MONITORING LOCATIONS AT KINGS BAY SUBMARINE SUPPORT FACILITY


MAIN GATE
FIGURE 10
LEGEND
□ DOSIMETRY DEVICES
▲ WATER SAMPLE POINT
○ SEDIMENT SAMPLE POINT
▨ SHORELINE SURVEY AREAS
N
KINGS BAY
PIER
CRAB ISLAND
0 1000 2000
SCALE IN FEET
CUMBERLAND SOUND
STAFFORD ISLAND
DRUM POINT ISLAND
CUMBERLAND ISLAND

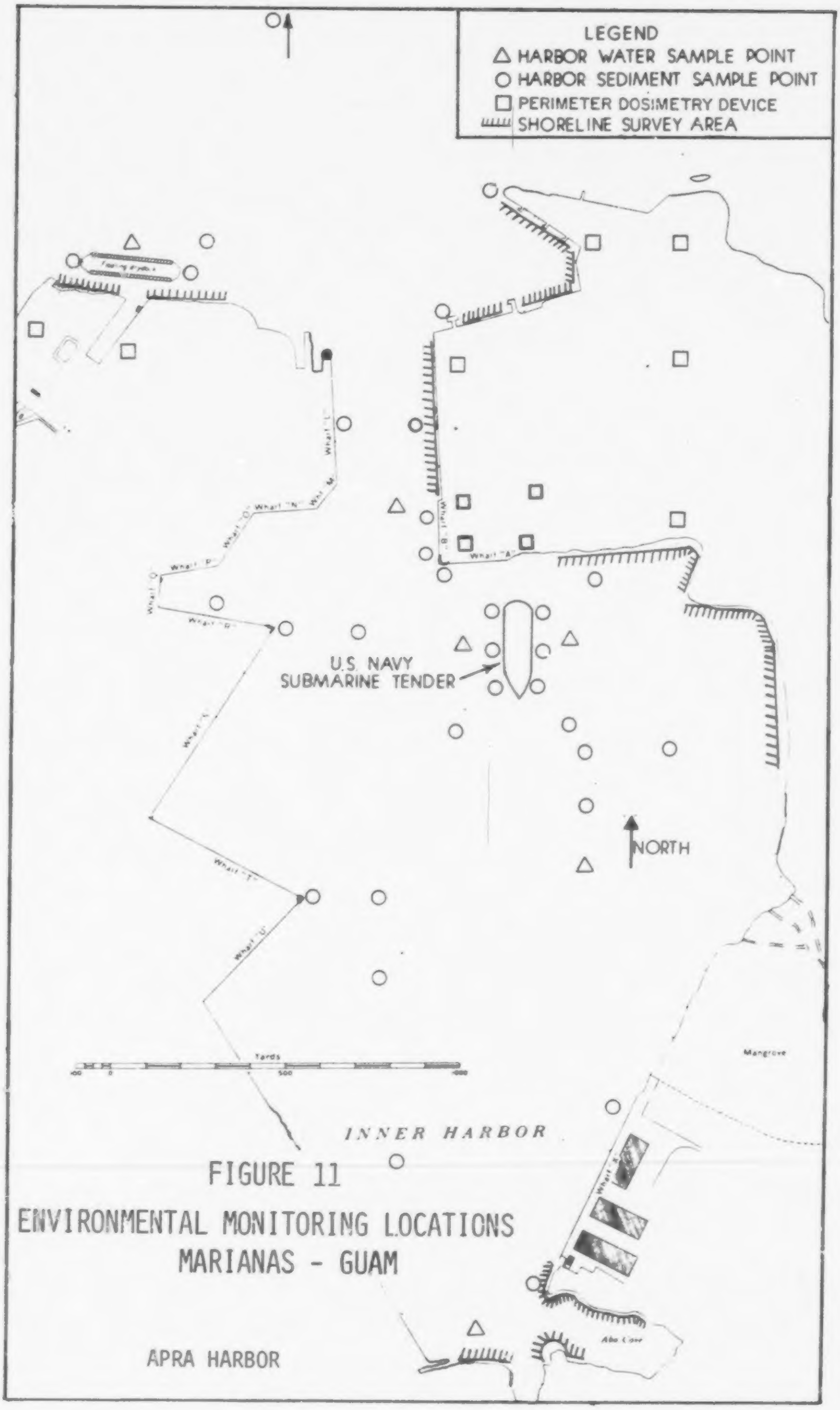

LEGEND
△ HARBOR WATER SAMPLE POINT
○ HARBOR SEDIMENT SAMPLE POINT
☐ PERIMETER DOSIMETRY DEVICE
ɯɯ SHORELINE SURVEY AREA
U.S. NAVY
SUBMARINE TENDER
NORTH
Wharf "A"
Wharf "B"
Wharf "L"
Wharf "M"
Wharf "N"
Wharf "O"
Wharf "P"
Wharf "R"
Wharf "T"
Wharf "U"
Yards
0
500
1000
INNER HARBOR
Mangrove
Abo Cove

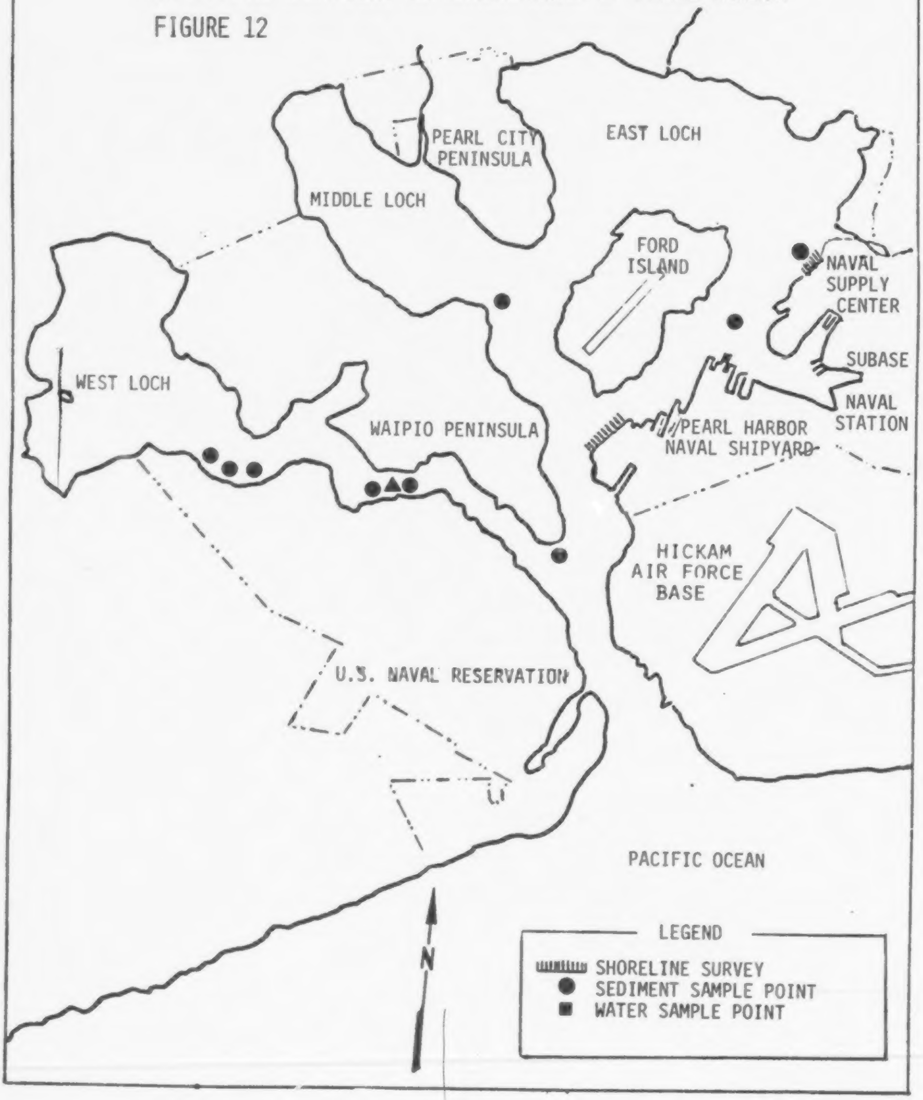
FIGURE 11

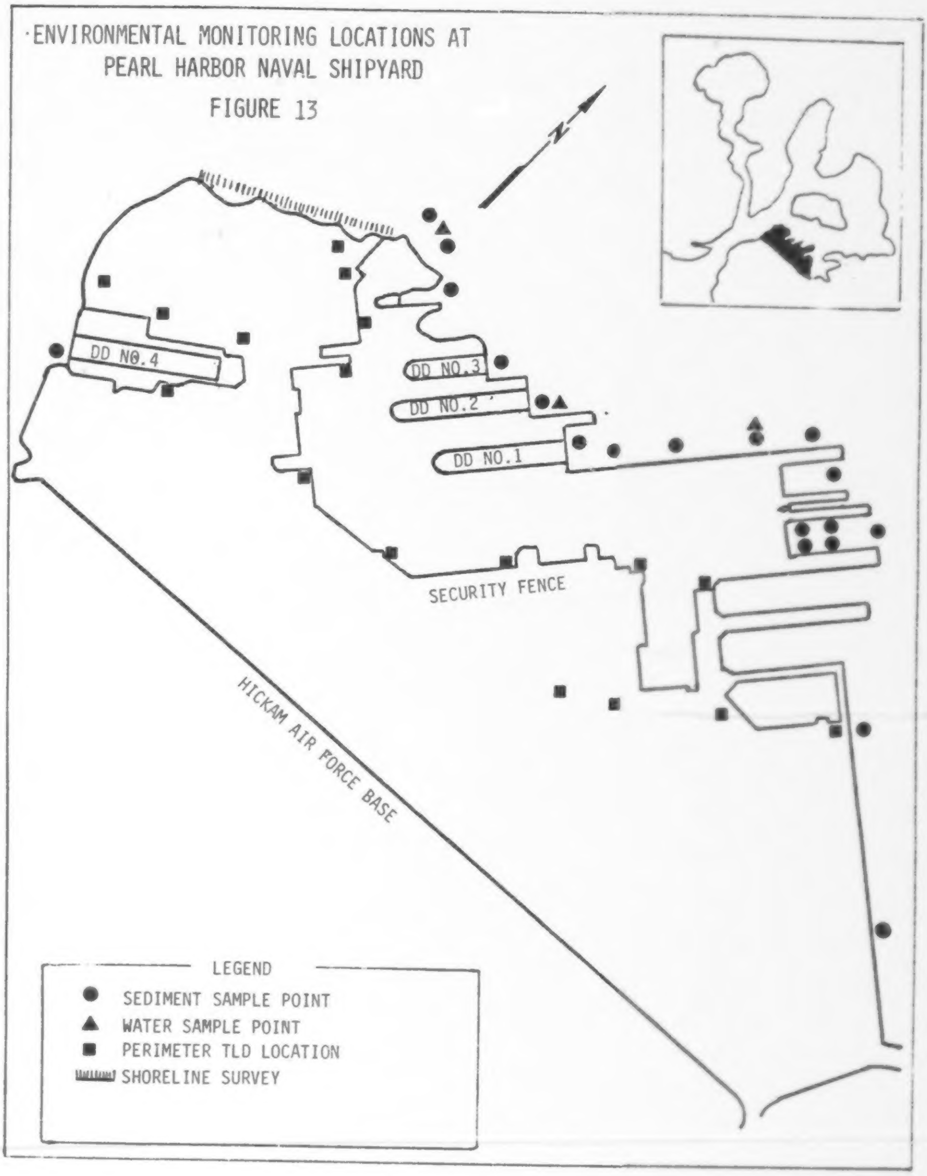
ENVIRONMENTAL MONITORING LOCATIONS
MARIANAS - GUAM

APRA HARBOR

OVERALL MAP OF PEARL HARBOR SHOWING ENVIRONMENTAL MONITORING LOCATIONS IN OTHER AREAS OF PEARL HARBOR

FIGURE 12


PEARL CITY PENINSULA
EAST LOCH
MIDDLE LOCH
FORD ISLAND
NAVAL SUPPLY CENTER
SUBASE
NAVAL STATION
WEST LOCH
WAIPIO PENINSULA
PEARL HARBOR NAVAL SHIPYARD
HICKAM AIR FORCE BASE
U.S. NAVAL RESERVATION
PACIFIC OCEAN
N
LEGEND
SHORELINE SURVEY
● SEDIMENT SAMPLE POINT
■ WATER SAMPLE POINT

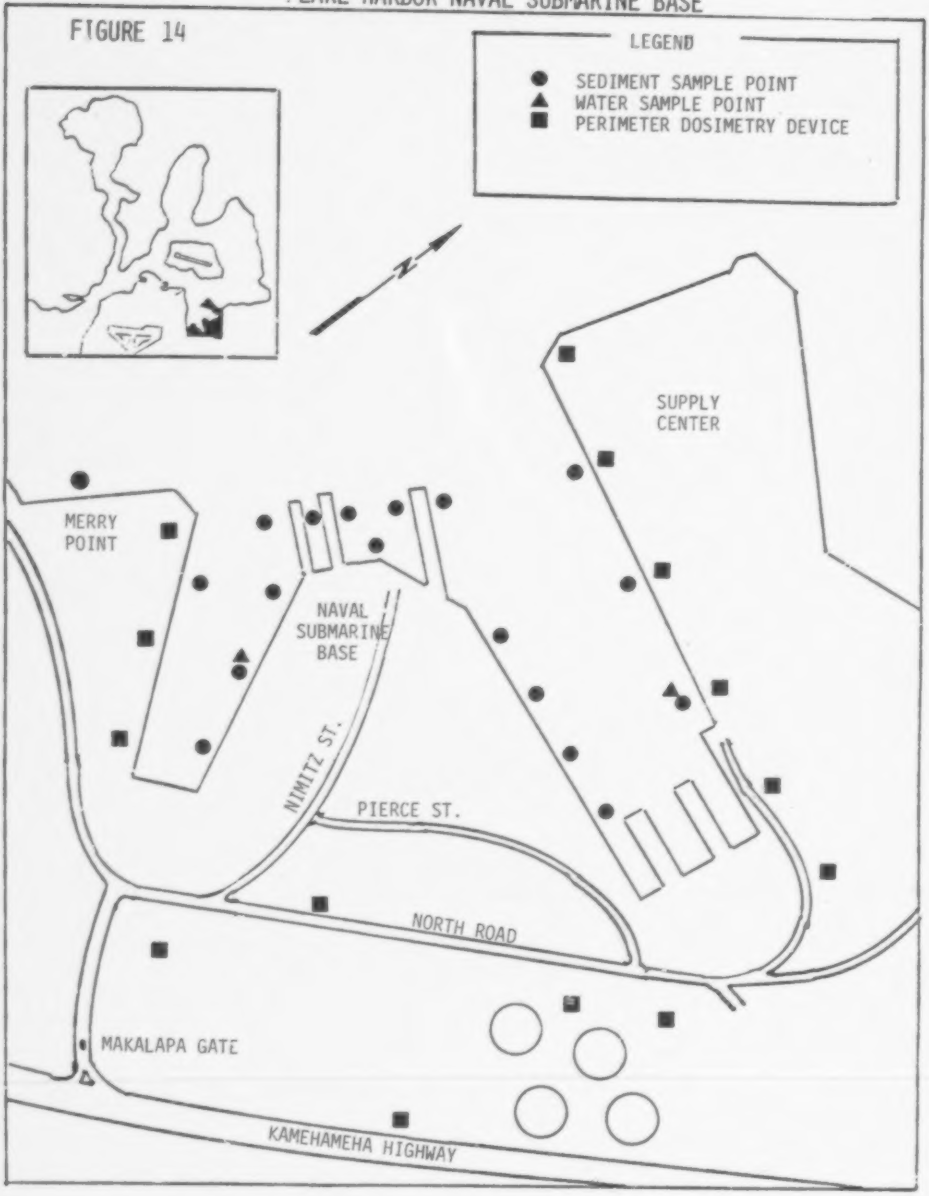


ENVIRONMENTAL MONITORING LOCATIONS AT
PEARL HARBOR NAVAL SHIPYARD
FIGURE 13

N
DD NO.4
DD NO.3
DD NO.2
DD NO.1
SECURITY FENCE
HICKAM AIR FORCE BASE
LEGEND
● SEDIMENT SAMPLE POINT
▲ WATER SAMPLE POINT
■ PERIMETER TLD LOCATION
SHORELINE SURVEY

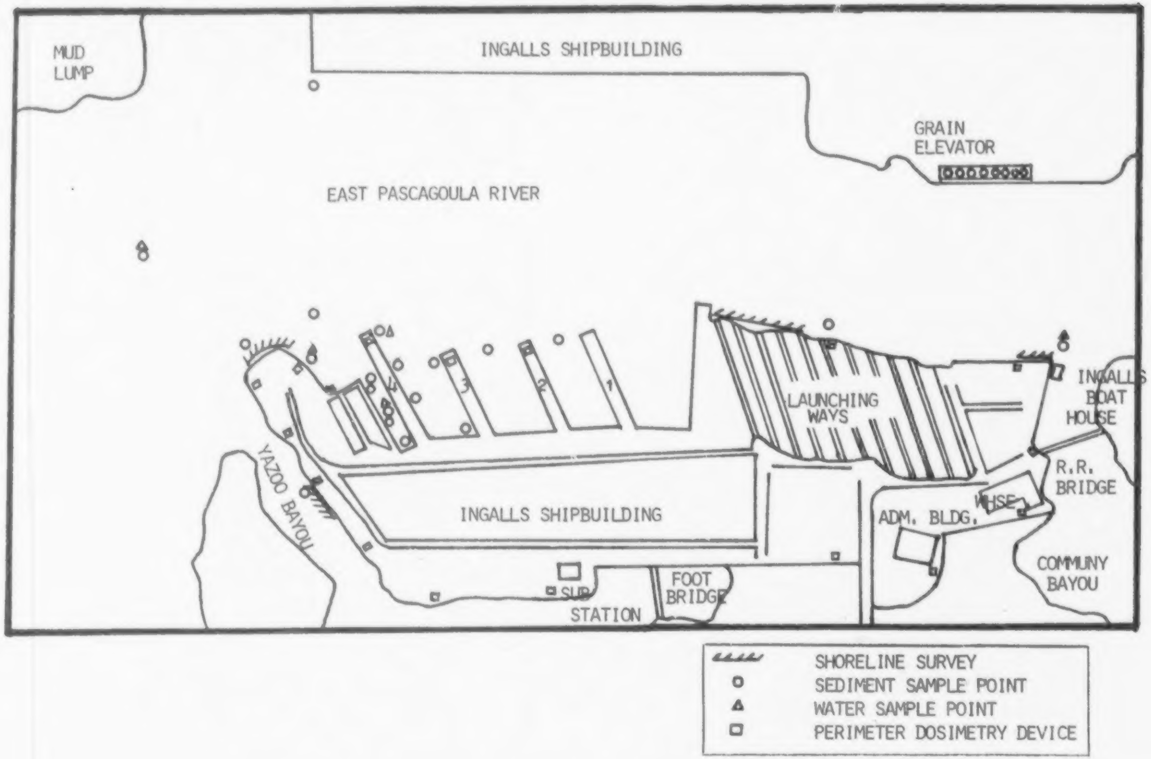
ENVIRONMENTAL MONITORING LOCATIONS AT PEARL HARBOR NAVAL SUBMARINE BASE

FIGURE 14


LEGEND
● SEDIMENT SAMPLE POINT
▲ WATER SAMPLE POINT
■ PERIMETER DOSIMETRY DEVICE
N
SUPPLY CENTER
MERRY POINT
NAVAL SUBMARINE BASE
NIMITZ ST.
PIERCE ST.
NORTH ROAD
MAKALAPA GATE
KAMEHAMEHA HIGHWAY

ENVIRONMENTAL MONITORING LOCATIONS AT INGALLS

FIGURE 15


MUD LUMP
INGALLS SHIPBUILDING
GRAIN ELEVATOR
EAST PASCAGOULA RIVER
1
2
3
4
LAUNCHING WAYS
INGALLS BOAT HOUSE
R.R. BRIDGE
WHSE.
ADM. BLDG.
COMMUNY BAYOU
YAZOO BAYOU
INGALLS SHIPBUILDING
SUB STATION
FOOT BRIDGE
SHORELINE SURVEY
○ SEDIMENT SAMPLE POINT
△ WATER SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE

ENVIRONMENTAL MONITORING LOCATIONS
AT PORTSMOUTH NAVAL SHIPYARD
PORTSMOUTH-KITTERY HARBOR
FIGURE 16

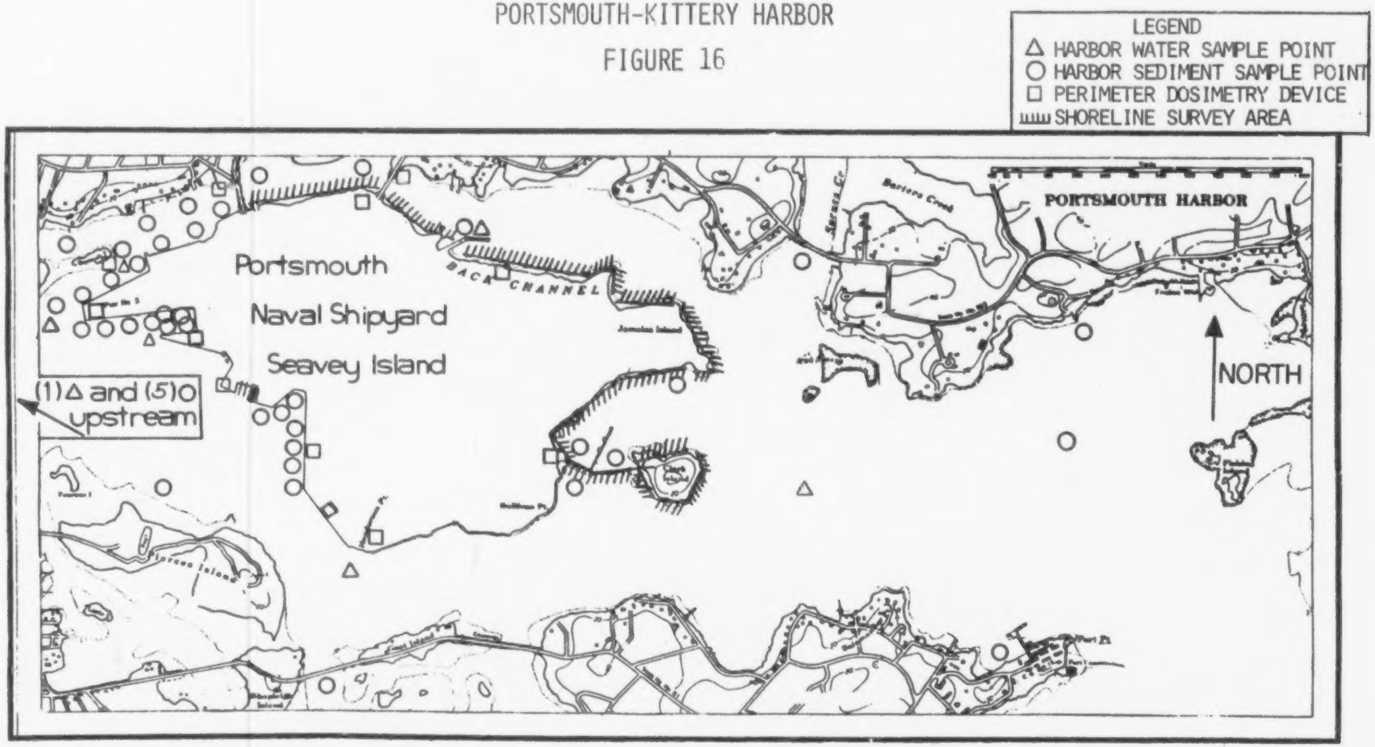

LEGEND
△ HARBOR WATER SAMPLE POINT
○ HARBOR SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
ɯɯ SHORELINE SURVEY AREA
PORTSMOUTH HARBOR
NORTH
Portsmouth
Naval Shipyard
Seavey Island
BACK CHANNEL
(1)△ and (5)○
upstream

FIGURE 17. U.S. NAVAL STATION & NAVAL SHIPYARD, CHARLESTON, SC.

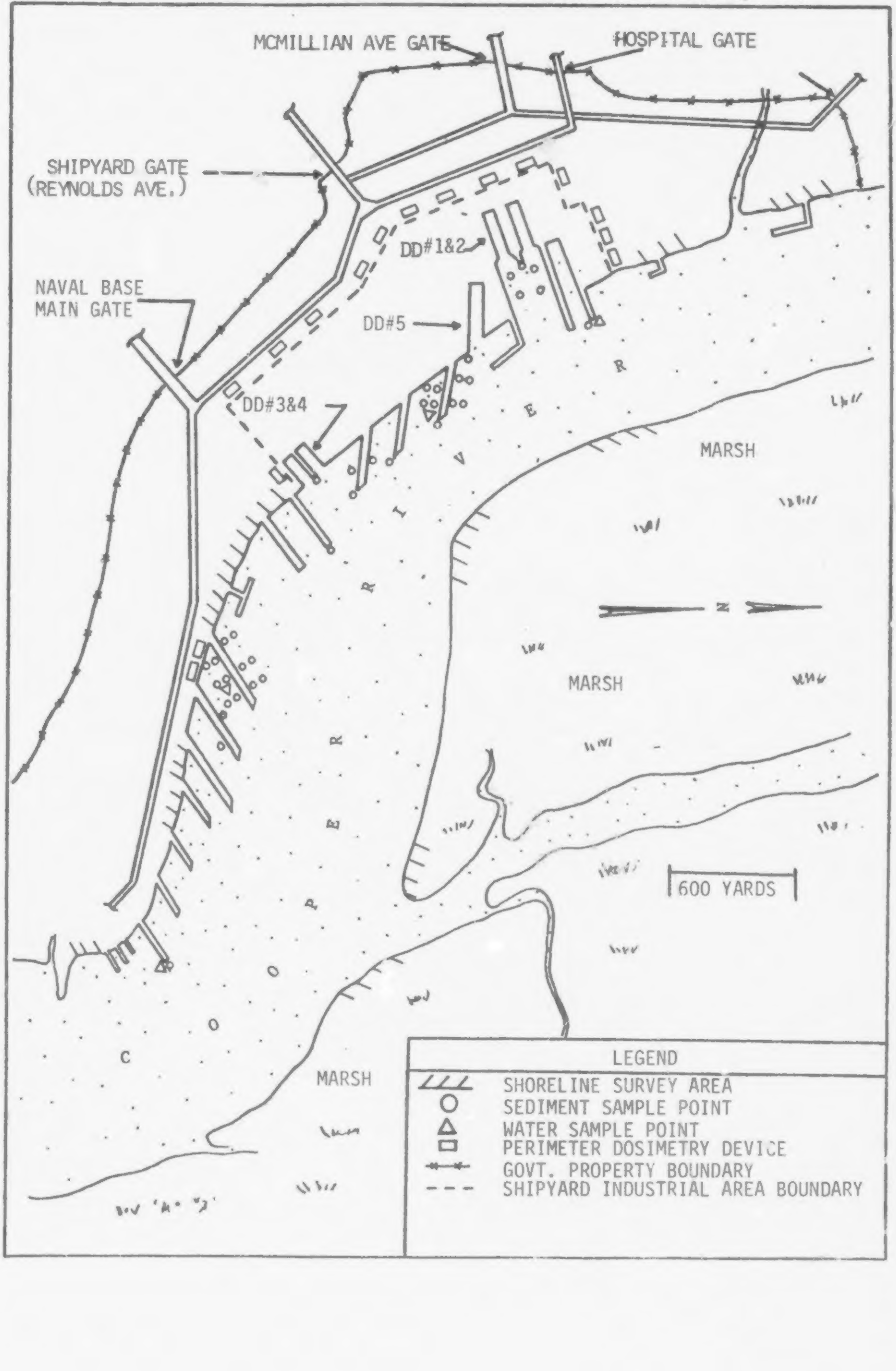
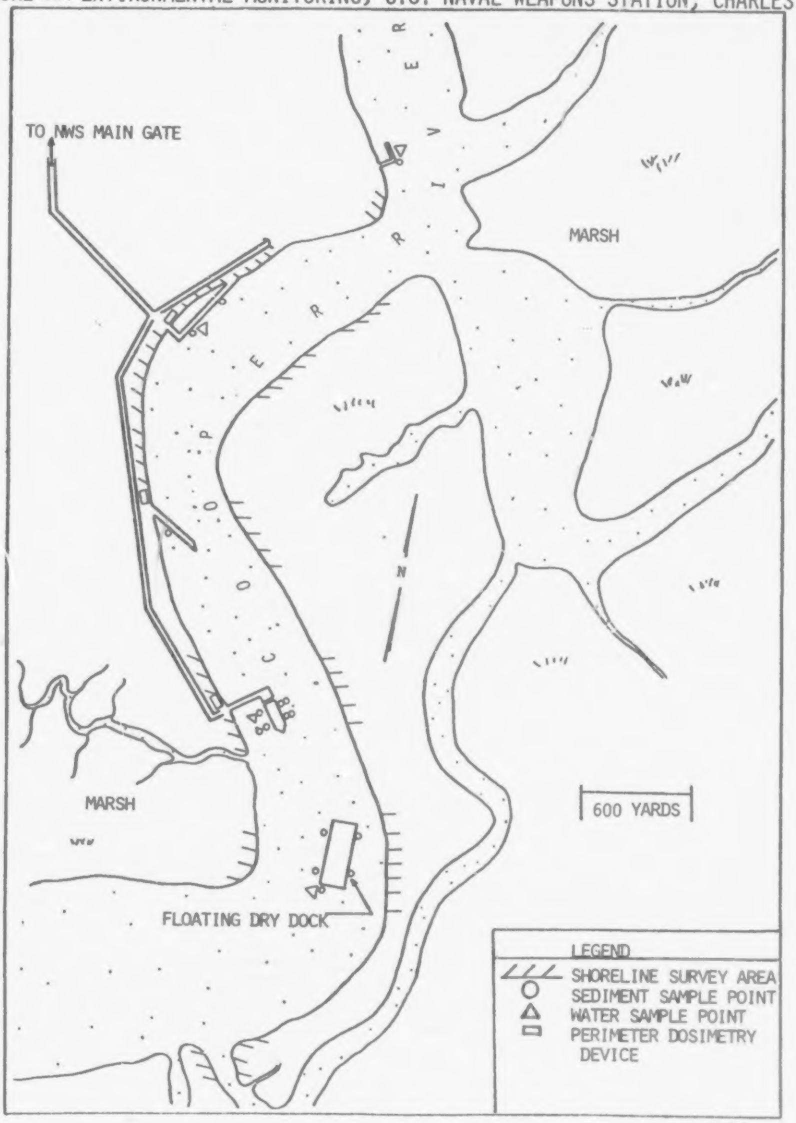

MCMILLIAN AVE GATE
HOSPITAL GATE
SHIPYARD GATE (REYNOLDS AVE.)
NAVAL BASE MAIN GATE
DD#1&2
DD#5
DD#3&4
COOPER RIVER
MARSH
MARSH
MARSH
N
600 YARDS
LEGEND
SHORELINE SURVEY AREA
○ SEDIMENT SAMPLE POINT
△ WATER SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
GOVT. PROPERTY BOUNDARY
SHIPYARD INDUSTRIAL AREA BOUNDARY

FIGURE 18: ENVIRONMENTAL MONITORING, U.S. NAVAL WEAPONS STATION, CHARLESTON


TO NWS MAIN GATE
COOPER RIVER
MARSH
N
MARSH
600 YARDS
FLOATING DRY DOCK
LEGEND
SHORELINE SURVEY AREA
SEDIMENT SAMPLE POINT
WATER SAMPLE POINT
PERIMETER DOSIMETRY DEVICE

ENVIRONMENTAL MONITORING LOCATIONS
AT NEWPORT NEWS SHIPBUILDING AND DRY DOCK COMPANY
FIGURE 19

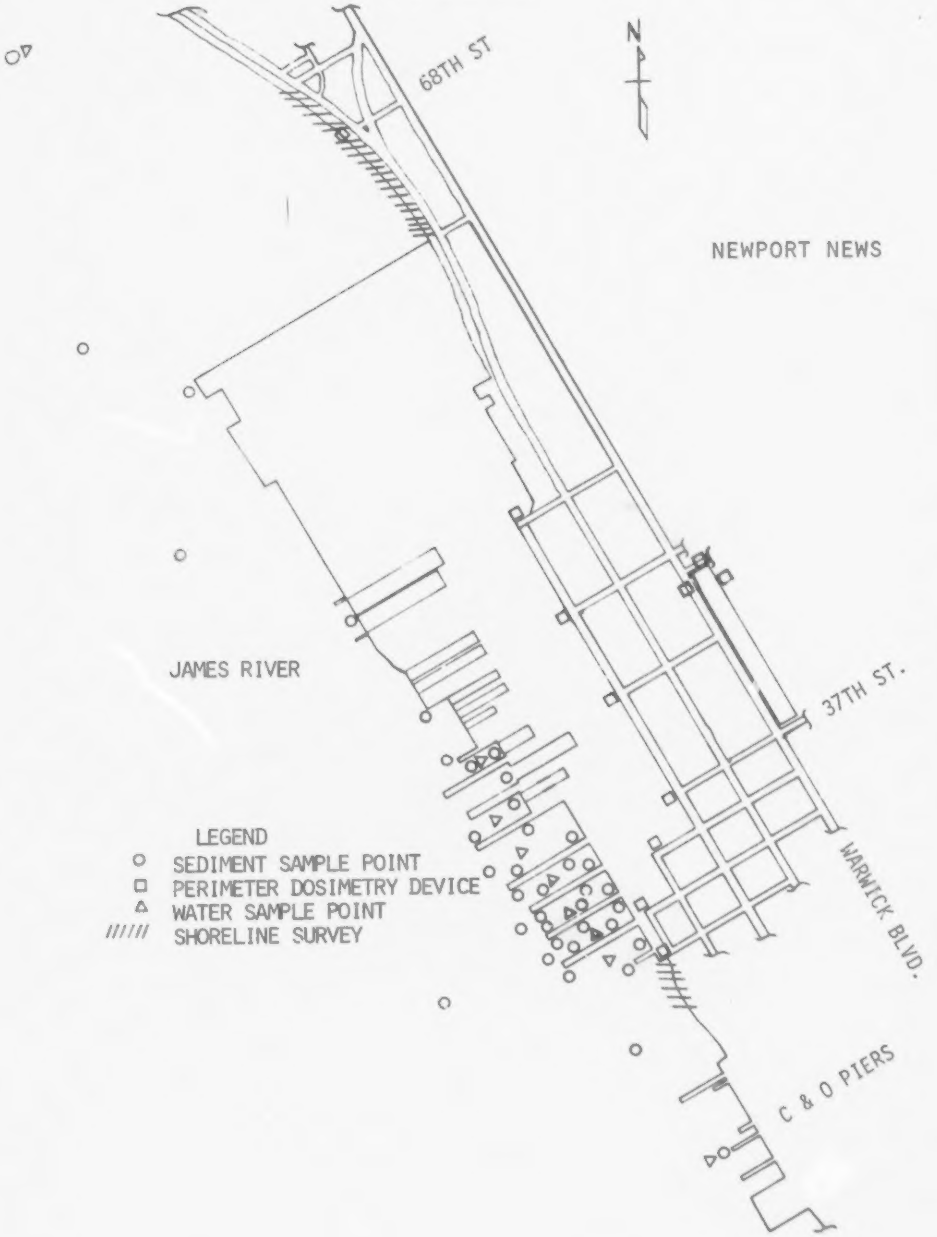

68TH ST
N
NEWPORT NEWS
JAMES RIVER
37TH ST.
WARWICK BLVD.
C & O PIERS
LEGEND
○ SEDIMENT SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
△ WATER SAMPLE POINT
////// SHORELINE SURVEY

FIGURE 20. ENVIRONMENTAL MONITORING LOCATIONS AT NORFOLK NAVAL SHIPYARD, PORTSMOUTH, VA

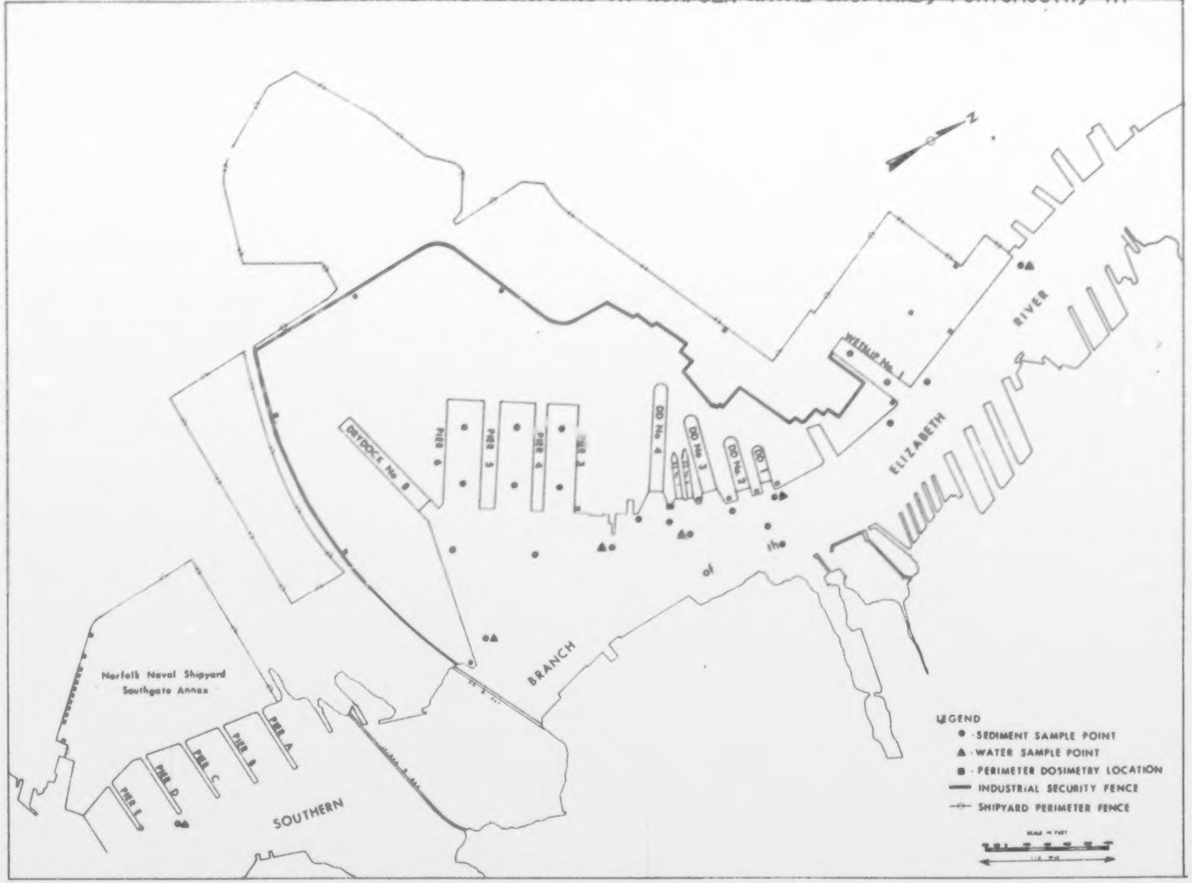

N
ELIZABETH
RIVER
of the
BRANCH
SOUTHERN
WETSLIP No. 1
DD 1
DD No. 2
DD No. 3
DD No. 4
PIER 3
PIER 4
PIER 5
PIER 6
DRYDOCK No 8
Norfolk Naval Shipyard
Southgate Annex
PIER A
PIER B
PIER C
PIER D
PIER E
LEGEND
● - SEDIMENT SAMPLE POINT
▲ - WATER SAMPLE POINT
■ - PERIMETER DOSIMETRY LOCATION
INDUSTRIAL SECURITY FENCE
SHIPYARD PERIMETER FENCE

FIGURE 21: ENVIRONMENTAL MONITORING LOCATIONS AT NORFOLK NAVAL STATION

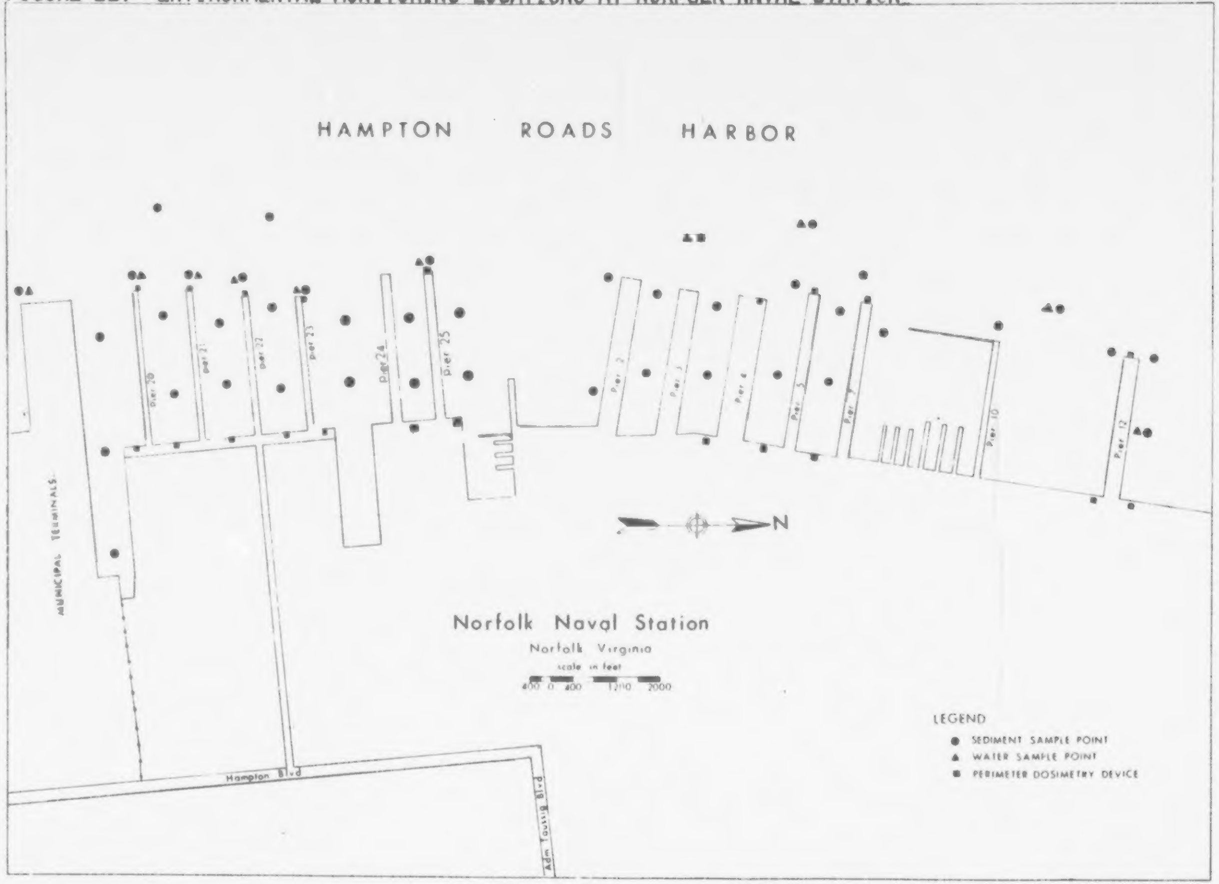
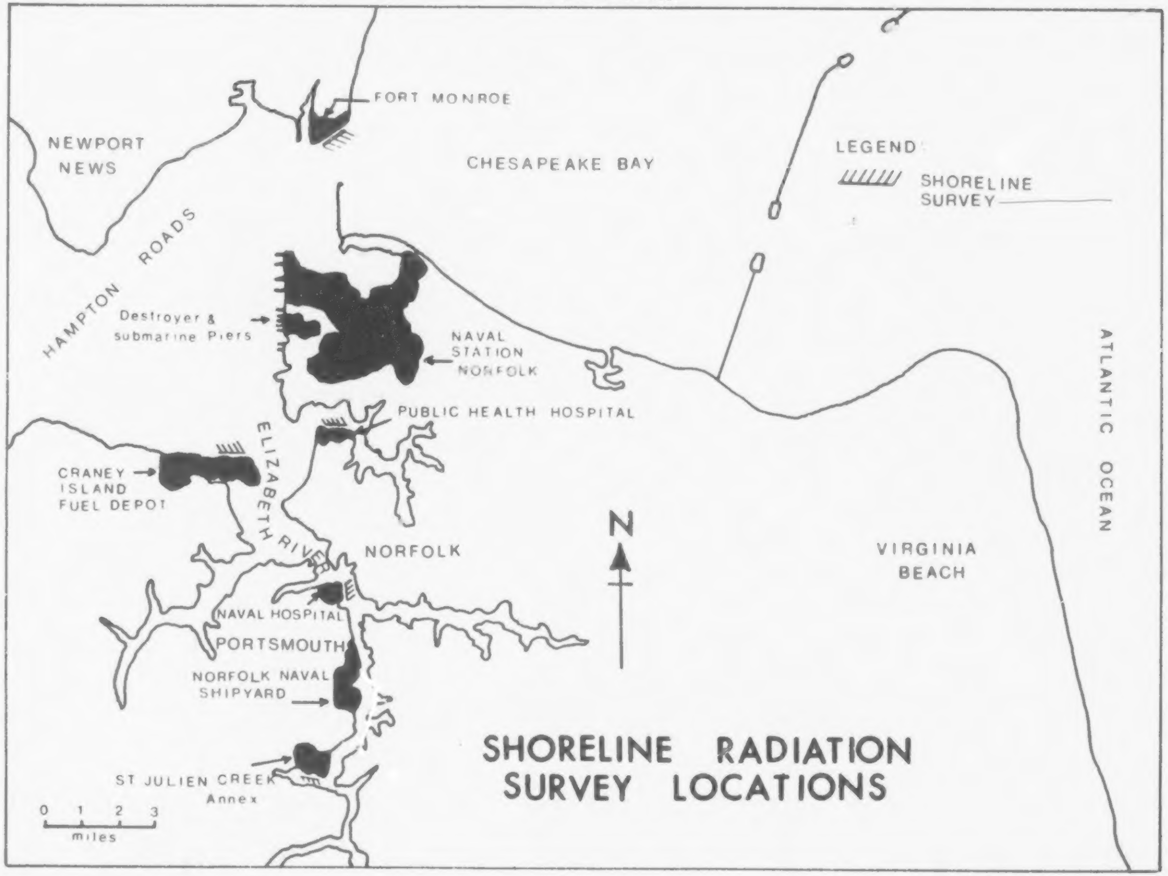

HAMPTON ROADS HARBOR
Pier 20
Pier 21
Pier 22
Pier 23
Pier 24
Pier 25
Pier 2
Pier 3
Pier 4
Pier 5
Pier 7
Pier 10
Pier 12
MUNICIPAL TERMINALS
N
Norfolk Naval Station
Norfolk Virginia
scale in feet
400 0 400 1200 2000
Hampton Blvd
Adm Taussig Blvd
LEGEND
● SEDIMENT SAMPLE POINT
▲ WATER SAMPLE POINT
■ PERIMETER DOSIMETRY DEVICE

FIGURE 22


FORT MONROE
NEWPORT NEWS
CHESAPEAKE BAY
LEGEND:
SHORELINE SURVEY
HAMPTON ROADS
Destroyer & submarine Piers
NAVAL STATION NORFOLK
ATLANTIC OCEAN
PUBLIC HEALTH HOSPITAL
CRANEY ISLAND FUEL DEPOT
ELIZABETH RIVER
NORFOLK
N
VIRGINIA BEACH
NAVAL HOSPITAL
PORTSMOUTH
NORFOLK NAVAL SHIPYARD
ST JULIEN CREEK Annex
0 1 2 3
miles

SHORELINE RADIATION SURVEY LOCATIONS

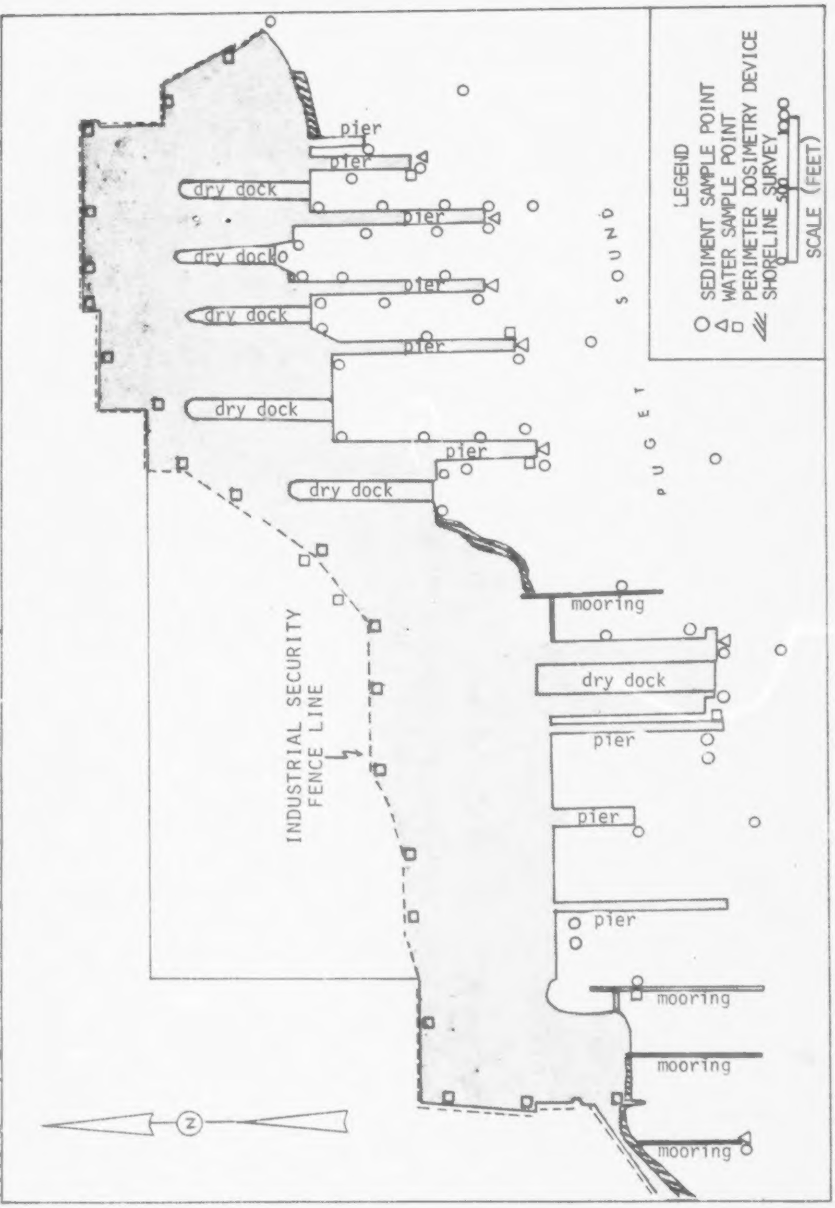
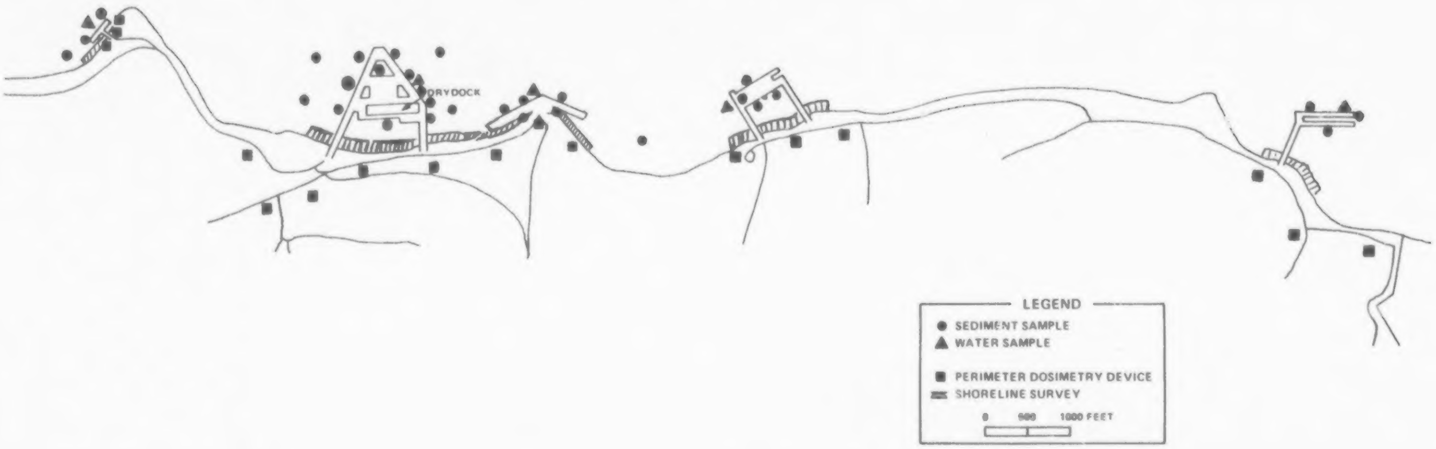

pier
pier
dry dock
pier
dry dock
pier
dry dock
pier
dry dock
pier
dry dock
mooring
dry dock
pier
pier
pier
mooring
mooring
mooring
INDUSTRIAL SECURITY FENCE LINE
PUGET SOUND
N
LEGEND
○ SEDIMENT SAMPLE POINT
△ WATER SAMPLE POINT
□ PERIMETER DOSIMETRY DEVICE
▨ SHORELINE SURVEY
0
500
1000
SCALE (FEET)

FIGURE 23. ENVIRONMENTAL MONITORING LOCATIONS, PUGET SOUND NAVAL SHIPYARD, BREMERTON, WA

ENVIRONMENTAL MONITORING LOCATIONS AT
NAVAL SUBMARINE BASE
BANGOR, WA
FIGURE 24


HOOD CANAL
N
DRYDOCK
LEGEND
● SEDIMENT SAMPLE
▲ WATER SAMPLE
■ PERIMETER DOSIMETRY DEVICE
▨ SHORELINE SURVEY
0 500 1000 FEET

Report NT-82-2
February 1982

# OCCUPATIONAL RADIATION EXPOSURE FROM U. S. NAVAL NUCLEAR PROPULSION PLANTS AND THEIR SUPPORT FACILITIES

## 1981

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Approved by

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Director
Naval Nuclear Propulsion Program

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## SUMMARY

Radiation exposures to Navy and civilian personnel monitored for radiation associated with U. S. Naval nuclear propulsion plants are summarized in this report. Navy personnel manned fifteen tenders, three submarine bases, 121 nuclear-powered submarines and twelve nuclear-powered surface ships which were in operation at the end of 1981. Nine shipyards were engaged in construction, overhaul, and refueling of these ships. The benefits of nuclear propulsion in our most capable combatant ships have long been recognized, and our nuclear-powered ballistic missile submarines form the most invulnerable element of the United States strategic deterrence.

Figure 1 shows that the total radiation exposure has been reduced to about one sixth of the amount in the peak year of 1966, even though the number of nuclear-powered ships nearly doubled during that period. Total man-rem in this figure is the sum of the annual exposures of each person monitored for radiation.

No civilian or military personnel in the Naval nuclear propulsion program have ever exceeded the Federal limit which allows five rem exposure for each year of age beyond age eighteen. Since 1967 no person has exceeded the Federal limit which allows up to three rem per quarter year, nor in this period has anyone exceeded the Navy's self-imposed limit of 5 rem per year for radiation associated with Naval nuclear propulsion plants.

No civilian or military personnel in the Naval nuclear propulsion program have ever received more than one tenth the Federal annual occupational exposure limit from internal radiation exposure caused by radioactivity associated with Naval nuclear propulsion plants.

The average occupational exposure of each person monitored has been about one quarter rem per year. The total lifetime exposure from radiation associated with Naval nuclear propulsion plants to date for all personnel monitored since 1954 has averaged about one rem per person.

According to the standard methods for estimating risk, the risk to the group of personnel occupationally exposed to radiation associated with Naval nuclear propulsion plants is less than the risk these same personnel have from exposure to natural background radiation or to medical radiation. This risk is small compared to the risks accepted in normal industrial activities, and it is small compared to the risks regularly accepted in daily life outside work.

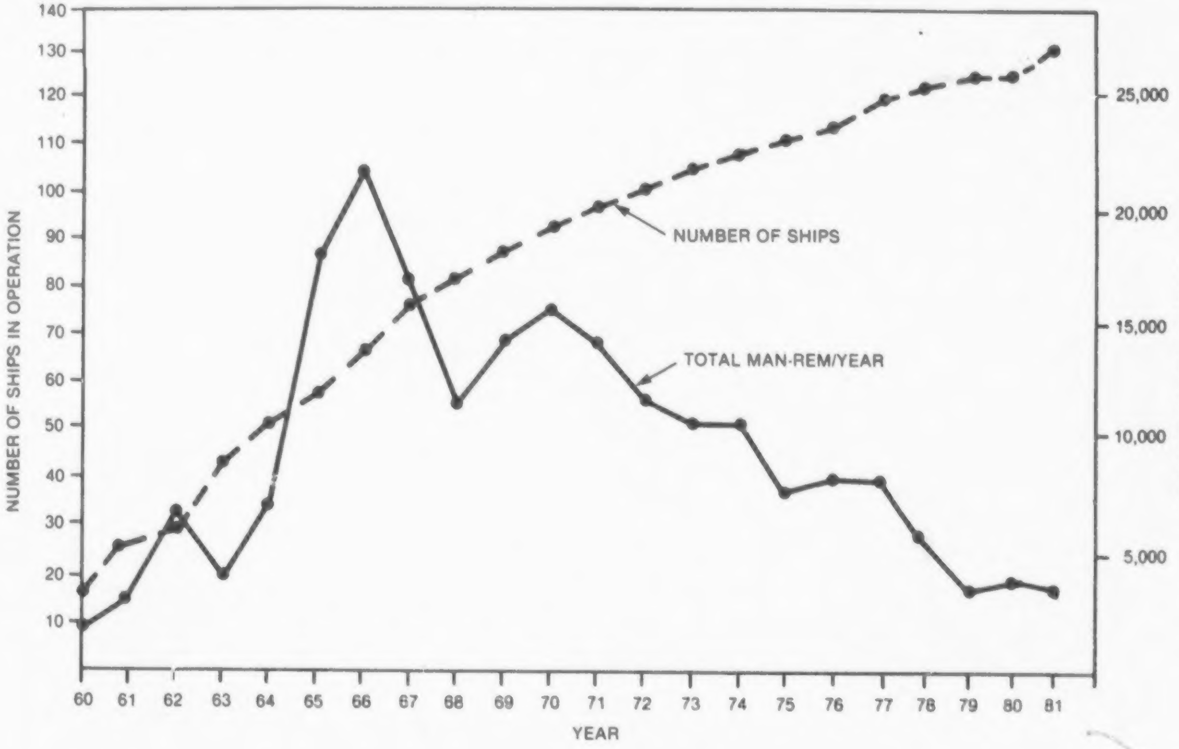

FIGURE 1

TOTAL RADIATION EXPOSURE RECEIVED BY MILITARY AND CIVILIAN PERSONNEL IN THE NAVAL NUCLEAR PROPULSION PROGRAM 1960-1981

## EXTERNAL RADIATION EXPOSURE

### Policy and Limits

The policy of the U. S. Navy is to reduce as low as reasonably achievable, exposure to personnel from ionizing radiation associated with Naval nuclear propulsion plants.

The radiation exposure limits used in the U. S. and abroad for whole body radiation exposure are 3 rem per quarter year and 5 rem accumulated dose for each year beyond age eighteen. These limits were recommended in 1958 by the U. S. National Committee ("Committee" was changed to "Council" when the organization was chartered by the U. S. Congress in 1964) on Radiation Protection and Measurements (ref 1) and by the International Commission on Radiological Protection (ref 2). They were adopted by the U. S. Atomic Energy Commission (AEC) and applied both within the AEC and to licensees in 1959 (ref 3). The U. S. Federal Radiation Council recommendation that these be used as guidance for Federal agencies was approved by President Eisenhower May 13, 1960 (ref 4). The U. S. Department of Labor adopted these same limits. A key part of each of these standards has been emphasis on minimizing radiation exposure to personnel.

In 1965 the International Commission on Radiological Protection (ref 5) reiterated the quarterly and accumulated limits cited above but suggested that exceeding 5 rem in one year should be infrequent. Although none of the other organizations referred to above changed its recommendations accordingly, the Naval nuclear propulsion program adopted 5 rem per year as a rigorous limit effective in 1967.

In 1971 the National Council on Radiation Protection and Measurements (ref 6) recommended that 5 rem be adopted as the annual limit under most conditions. In 1974 the Atomic Energy Commission (now Department of Energy) (ref 7) established 5 rem as its annual limit. In 1977 the International Commission on Radiological Protection (ref 8) deleted the accumulated limit and recommended 5 rem as the annual limit. In 1979 the Nuclear Regulatory Commission issued a proposed change to the Code of Federal Regulations Title 10, Part 20 to require its licensees to use 5 rem as an annual limit. In January 1981, the Environmental Protection Agency recommended that Federal agencies use 5 rem as an annual limit (ref 9).

The Navy limits for the nuclear propulsion program since 1967 have been:

3 rem per quarter year
5 rem per year

---

References are listed on pages 44 and 45.

Special limits are in effect such as for hands and feet; however, there have been few cases where these limits have been more restrictive than the whole body radiation exposure limits. Therefore, the radiation exposures discussed in this report are nearly all from whole body radiation. Controls are also in effect to minimize any occupational radiation exposure to the unborn child of a pregnant worker.

Each organization in the Navy nuclear propulsion program is required to have an active program to reduce radiation exposure to the minimum practicable.

## Source of Radiation

The radiation discussed in this report originates from pressurized water reactors. Water circulates through a closed piping system to transfer heat from the reactor core to a secondary steam system isolated from the reactor cooling water. Trace amounts of corrosion and wear products are carried by reactor coolant from reactor plant metal surfaces. Some of these corrosion and wear products are deposited on the reactor core and become radioactive from exposure to neutrons. Reactor coolant carries some of these radioactive products through the piping systems where a portion of the radioactivity is removed by a purification system. Most of the remaining radionuclides transported from the reactor core deposit in the piping systems.

The reactor core is installed in a heavy-walled pressure vessel within a primary shield. This shield limits radiation exposure from the gammas and neutrons produced when the reactor is at power. Reactor plant piping systems are installed primarily inside a reactor compartment which is surrounded by a secondary shield. Access to the reactor compartment is permitted only after the reactor is shut down. Most radiation exposure to personnel comes from inspection, maintenance and repair inside the reactor compartment. The major source of this radiation is cobalt 60 deposited inside the piping systems. Cobalt 60 emits two high energy gammas and a low energy beta for every radioactive decay. Its half-life is 5.3 years.

Neutrons produced when reactor fuel fissions are shielded by both primary and secondary shields before penetrating to occupied areas. Radiation exposure to personnel from these neutrons during reactor operation has been much less than from gammas. After reactor shutdown, when shipyard and other support facility work is done, no neutron exposure is detectable. As a result, the radiation exposures discussed in this report are nearly all from gamma radiation.

## Control of Radiation During Reactor Plant Operation

Reactor plant shielding is designed to minimize radiation exposure to personnel. Shield design criteria establishing radiation levels in various parts of each nuclear-powered ship are personally approved by the Director of the Naval Nuclear Propulsion Program.

Ship design is also controlled to keep locations, such as duty stations where personnel need to spend time, as far as practicable away from the reactor compartment shield. Special attention is paid to living quarters. For example, the shield design criteria were established such that a person would have to spend more than 48 hours per day in living quarters to exceed exposure limits (which is impossible since there are only 24 hours in a day).

Resulting radiation exposure to those aboard ship outside propulsion plant spaces during reactor plant operation is not any greater than natural background radiation. For submarine operating personnel outside the propulsion plant, the combination of low natural radioactivity in ship construction materials and reduced cosmic radiation under water provides less radiation exposure at sea than the public receives ashore. Those who operate the nuclear propulsion plant receive more radiation exposure in port during maintenance and overhaul periods than they receive from operating the propulsion plant at sea.

## Control of Radiation in Support Facilities

Tenders for nuclear-powered submarines and surface ships are designed so that radioactive material is handled only in specially designed and shielded nuclear support facilities. Submarine bases and shipyards limit to the minimum, the number of places where radioactive material is allowed. Specific traffic routes are required to be used for any movement of radioactive material outside these nuclear support facilities. A radioactive material accountability system is used to ensure no radioactive material is lost or misplaced in a location where personnel could unknowingly be exposed. Regular inventories are required for every item in the radioactive material accountability system. Radioactive material is tagged with yellow and magenta tags bearing the standard radiation symbol and the measured radiation level. Radioactive material removed from a reactor plant is required to be placed in yellow plastic, and the use of yellow plastic is reserved solely for radioactive material. All personnel assigned to a tender, submarine base or shipyard are trained to recognize that yellow plastic identifies radioactive material and to initiate immediate action if radioactive material is discovered out of place.

Access to radiation areas is controlled by radiological control personnel. Personnel are required to wear dosimetry devices to enter these areas. Dosimetry devices are also posted outside these areas to verify that personnel outside these areas do not require monitoring. Frequent radiation surveys are required using instruments which are checked before use and calibrated regularly. Areas where radiation levels are greater than 0.1 rem per hour are called high radiation areas and are locked or guarded.

## Dosimetry

Thermoluminescent dosimeters (TLDs) are the dosimetry devices worn by personnel to measure their exposure to gamma radiation. The thermoluminescent dosimeter contains two chips of calcium fluoride with added manganese. It is characteristic of thermoluminescent material that radiation causes internal changes which make the material, when subsequently heated, give off an amount of light directly proportional to the radiation dose. In order to make it convenient to handle, these chips of calcium fluoride are in contact with a metallic heating strip with heater wires extending through the ends of a surrounding glass envelope. The glass bulb is protected by a plastic case designed to permit the proper response to gammas of various energies. Gammas of such low energy that they will not penetrate the plastic case constitute less than a few percent of the total gamma radiation present. To read the radiation exposure, a trained operator removes the glass bulb and places it in a TLD reader so that the metal heater wires contact an electrical circuit. An electronically controlled device heats the calcium fluoride chips to several hundred degrees centigrade in a timed cycle, and the intensity of light emitted is measured and converted to a digital readout in units of rem. The heating cycle also anneals the calcium fluoride chips so that the dosimeter is zeroed and ready for subsequent use. The entire cycle of reading a TLD described here takes about thirty seconds. This rapid readout capability was one reason for changing from film badges to TLDs. The use of TLDs permits more frequent measurement of a worker's radiation exposure than film badges.

TLDs are required to be processed at least daily in Naval shipyards. Aboard ship TLDs are required to be processed at least monthly except that daily processing is required for anyone entering a reactor compartment or high radiation area. To ensure accuracy, a number of calibration checks are performed on the TLD system. For example, each TLD is checked every six months for response within fifteen percent of a known exposure. Also each TLD reader must check within one percent against its internal calibration standard prior to each use and at least hourly when the reader is in use.

Pocket ionization chambers with an eyepiece permit the wearer to read his own radiation exposure. This pocket dosimeter is required in addition to a TLD when entering a reactor compartment or a high radiation area. Pocket dosimeters are used to enable the wearer to keep track of his own radiation exposure during a work period. The official record of radiation exposure is obtained from the TLD.

Dosimetry devices are worn on the trunk of the body, normally at the waist or chest, whichever will receive the higher exposure. In some special situations dosimeters are worn at other locations, for example on the hands or fingers or head.

Prior to 1974 film badges were used to measure radiation exposure. Film packets like those used for dental X-ray were placed in holders designed to allow differentiating between types of radiation. The darkness of the processed film was measured with a densitometer and converted to units of radiation exposure. When the first personnel radiation exposures were measured in the Naval Nuclear Propulsion Program there already was widespread photodosimetry experience in the Navy and precise procedures existed to provide reproducible results.

Each film badge was clearly marked with a name or number corresponding to the individual to whom it was assigned. This number was periodically checked by a radiological control technician before a worker entered a high radiation area. In high radiation areas every worker also wore a pocket dosimeter which was read by radiological control personnel when the worker left the area. At the end of each month when the film badges were processed, the film badge measurements were compared with the sum of the pocket dosimeters readings. The film badge results were, with few exceptions, entered in the permanent personnel radiation exposure records.

Discrepancies between film badge and pocket dosimeter measurements were investigated. These investigations included making independent estimates of the worker's exposure using such methods as time spent in the specific radiation area and comparing the estimates with the two measurements to determine which measurement was in error. If the error could not be determined, then the higher exposure was recorded for the worker. In nearly all cases this was the film badge measurement.

Results of numerous tests conducted by shipyards under the same conditions that most radiation exposure was received showed that film measurements averaged fifteen percent higher than actual radiation exposures. This was a conscious conservatism to ensure that under the worst case, the film measurement was not less than the actual radiation exposure. Film response varies with the energy of the gamma radiation. The calibration of the film was performed at high energy where the film has the least response to radiation exposure. Radiation of lower energies corresponding to scattered radiation from shielded cobalt 60 causes the film to indicate more radiation exposure than is present.

Data gathered in over 20 years of neutron monitoring aboard ship using neutron film badges demonstrated that the monitored individuals did not receive neutron exposure above the minimum detection level for neutron film. Naval nuclear-powered ships and their support facilities now use lithium fluoride TLDs to monitor neutron exposure of the few workers exposed to neutron sources used for radiation instrument calibration and for reactor plant instrumentation. These measured neutron exposures have been added to gamma exposures in the total whole body radiation exposure in this report, but because neutron exposures are so low, the radiation exposures in this report are nearly all from gamma radiation.

Monitoring for beta radiation is not normally required because betas cannot penetrate the metal boundaries of the reactor coolant system. Beta radiation needs to be considered in maintenance or repair operations only when systems are opened so that personnel are close to surfaces which have been contaminated with radioactive corrosion products from reactor coolant. In these cases normal clothing or eyeglasses or plastic contamination control materials completely shield beta radiation of the energies normally present. Support facilities routinely provide such shielding to eliminate personnel radiation exposure from betas.

Monitoring for alpha radiation is not a normal part of operation or maintenance of Naval nuclear propulsion plants. However, alpha monitoring is sometimes necessary to identify radium daughter products naturally present in the atmosphere.

## Physical Examinations

Radiation medical examinations have been required since the beginning of the Naval nuclear propulsion program for personnel exposed to radiation. In these examinations the doctor pays special attention to any condition which might indicate that radiation exposure would cause an increased degree of risk. Passing this examination is a prerequisite for obtaining the dosimetry badge which permits entry to areas where radiation exposure can be received. For military personnel who have already been screened by physical examinations, few fail this radiation medical examination. For civilian shipyard workers, the failure rate is a few percent. However, failure of this examination does not mean a shipyard worker will not have a job. Since shipyard workers spend most of their time on nonradioactive work, inability to qualify for radioactive work does not restrict their job opportunities. No shipyard worker in the Naval nuclear propulsion program has been fired for inability to pass a radiation medical examination.

Radiation medical examinations are given prior to initial radiation work, periodically thereafter (at least every three years), and at termination of radiation work in the nuclear propulsion program (or at termination of employment).

A radiation medical examination includes review of medical history to determine, among other subjects, past radiation exposure, history of cancer, history of radiation therapy, and family history of cancer. In the medical examination particular attention is paid to evidence of cancer as well as cataracts in the eyes. Laboratory procedures include urinalysis, blood analysis, and comparison of blood constituents to a specific set of standards. Chest X-rays with full size film to reduce radiation exposure were also a routine part of all radiation medical examinations until 1977. At that time routine chest X-rays were discontinued, further reducing radiation exposure of workers. Chest X-rays are now performed when clinically indicated at the discretion of the medical officer. In the event disqualifying conditions are found in an examination of Naval civilian or military personnel, the individual is barred from receiving occupational radiation exposure and the results of the examination are reviewed by the Bureau of Medicine and Surgery Radiation Effects Advisory Board. Only after approval of the board would the individual be permitted to receive occupational radiation exposure.

Shipyard Training:

Periodic radiological control training is performed to ensure each person understands the general and specific radiological aspects which he might encounter, understands his responsibility to the Navy and the public for safe handling of radioactive materials, understands the risks associated with radiation exposure and understands his responsibility to minimize his own radiation exposure. Training is also provided on the biological risk of radiation exposure to the unborn child. Prior to being authorized to perform radiation work, an employee is required to complete satisfactorily a radiological control training course, including a written examination. Typical course lengths for workers range from 16 to 32 hours. In written examinations on radiological controls, short answer questions, such as multiple choice and true-false questions, are not normally used. Following are the minimum training requirements for workers:

1. Radiation Exposure Control

    a. State the limits for whole body penetrating radiation. Explain that the rem is a unit of biological dose from radiation.

    b. Explain how "stay times" are used.

    c. Be aware of the seriousness of violating instructions on radiation warning signs and unauthorized passage through barriers; be aware of penalties for violating these requirements.

    d. Discuss procedures and methods for minimizing exposure such as working at a distance from a source, reducing time in a radiation area, and shielding.

    e. Discuss potential sources of radiation associated with work performed by the individual's trade.

    f. State where dosimetry equipment shall be placed on an individual's body.

    g. Demonstrate ability to read all types of dosimeters in use.

    h. Discuss importance of the individual keeping track of his own exposure.

    i. Be aware of the significance of personnel radiation exposure. The National Council on Radiation Protection and Measurements has stated that while exposures of workers and the general population should be kept to the lowest practicable level at all times, the presently permitted exposures represent a level of risk small compared with other hazards of life. The Nuclear Regulatory Commission has stated, "Control of exposure to radiation is based on the assumption that any exposure, no matter how small, involves some risk." The risk of injury from radiation associated with Naval nuclear propulsion plants is low compared to the occupational and nonoccupational risks accepted in everyday life.

2. Contamination Control

   a. Discuss how contamination is controlled during radioactive work (e.g., containment in plastic bags and use of contamination containment areas).

   b. Discuss procedures for preventing contamination of personnel and how contamination is detected on personnel.

   c. Discuss how contamination is removed from contaminated objects and personnel.

   d. Discuss potential sources of contamination associated with work performed by the individual's trade.

   e. State the beta-gamma surface contamination limit. Discuss the meaning of the units of the limit.

   f. Demonstrate proper procedure for donning and removing a full set of anticontamination clothing.

   g. Demonstrate proper procedures for entering and leaving a contaminated area including proper procedures for self-monitoring.

   h. Explain what radioactive contamination is. Explain the difference between radiation and radioactive contamination.

   i. For personnel required to work in containment areas (e.g., glove bags or tents), demonstrate proper procedures for working in these areas. (This ability is often demonstrated on a mock-up.)

   j. For personnel who are likely to encounter airborne radioactivity, demonstrate the proper procedure for donning and removing the type of respiratory equipment the individual will be required to wear. For personnel who are required to wear respiratory equipment with anticontamination clothing, this demonstration shall be performed when donning and removing anticontamination clothing. The demonstration shall include any leak checks required to be made to test for proper operation of respiratory equipment.

k. For personnel who are likely to encounter airborne radioactivity, state the conditions which require wearing masks, air supplied respirators, or air supplied hoods.

3. Accountability of Radioactive Materials - Know that radioactive materials are accounted for when transferred between radiologically controlled areas by tagging, by recording dispostion of material, and by specific authorization of radiological control personnel.

4. Waste Disposal - Discuss how the individual workers can reduce the amount of radioactive liquid and solid waste.

5. Radiological Incidents

   a. Discuss the need for consulting radiological control personnel when questions or incidents occur.

   b. Discuss procedures to be followed after a spill of material (liquid or solid) which is or might be radioactive.

   c. Discuss procedures to be followed when notified that airborne radioactivity is above the limit.

   d. Demonstrate the action to be taken in event of a spill of radioactive liquid. This ability shall be demonstrated during a drill.

   e. Discuss the action to be taken when an individual discovers his dosimeter is off-scale.

6. Responsibilities of Individuals - Discuss actions required in order to fulfill workers' responsibilities. Include the responsibility of the individual to inform his employer of previous or concurrent occupational radiation exposure received.

In addition to passing a written examination, completion of this training course requires satisfactory performance during basic types of simulated work operations. For an employee to continue as a radiation worker, he has to requalify in a manner similar to the initial qualification at least every two years. In between these qualification periods, personnel are required to be selected at random for additional examination to determine how well the knowledge has been retained. Training is also conducted by individual shop instructors in the specific job skills for radiation work within each trade. For complex jobs this is followed by special training for the specific job, frequently using mock-ups outside radiation areas.

Radiological control technicians are required to complete a course of about six months in radiological controls, to demonstrate their practical abilities, and to pass comprehensive written and oral examinations. Radiological control supervisors are required to have at least the same technical knowledge and abilities as the technicians; however, passing scores for supervisors' examinations are higher or supervisors' examinations are more difficult than for technicians. Oral examinations are conducted by senior radiological control managers and require personnel to be able to evaluate symptoms of unusual radiological control situations. The radiological control technician or supervisor is required to evaluate initial symptoms, state immediate corrective action required, state what additional measurements are required, and do a final analysis of the measurements to identify the specific problem. Subsequent to qualification, periodic training sessions are required in which each radiological control technician and supervisor demonstrates ability to handle situations such as are used in the oral examinations. At least every two years, radiological control personnel have to requalify through written and oral examinations similar to those used for initial qualification. Radiological control technicians and supervisors are required to demonstrate their practical abilities frequently through unannounced drills.

In addition to the above training for those who are involved in radioactive work, each shipyard employee not involved in radioactive work and each person assigned to a nuclear-powered ship or a support facility is required to receive basic radiological training which is repeated at least annually. This training is to ensure personnel understand the posting of radiation areas, the identification of radioactive materials, and not to cross radiation barriers. This instruction also explains that the radiation environment of personnel outside radiation areas and outside the ship or shipyard is not significantly affected by nuclear propulsion plant work.

## Nuclear Power Training

Military personnel who operate Naval nuclear propulsion plants are required to pass a six month basic training course at nuclear power school and a six month qualification course at a land-based prototype of a shipboard reactor plant. Each nuclear-trained officer and enlisted man receives extensive radiological control training including lectures, demonstrations, practical work, radiological control drills and written and oral examinations. This training has emphasized the ability to apply basic information on radiation and radioactivity.

Those enlisted personnel who will have additional responsibilities for radiological control are designated Engineering Laboratory Technicians and receive an additional three months training after completion of the one year program.

Prior to becoming qualified as the Engineer Officer, that is, the head of the engineering department of a nuclear-powered ship, a nuclear-trained officer must pass a one day written examination and a sequence of oral examinations conducted at Naval Reactors headquarters. A key part of these qualification examinations is radiological controls.

Immediately before serving as Commanding Officer of a nuclear-powered ship, an officer attends a three month course at Naval Reactors headquarters. The radiological controls portion of this is an advanced course and assumes the officer starts with detailed familiarity with shipboard radiological controls. The officer must pass both written and oral examinations in radiological controls during this course prior to assuming command of a nuclear-powered ship.

## Radiation Exposure Reduction

Maintaining personnel radiation exposures as low as reasonably achievable involves all levels of management in nuclear-powered ships and their support facilities. Operations, maintenance and repair personnel are required to be involved in this subject; it is not left solely to radiological control personnel. To evaluate the effectiveness of radiation exposure reduction programs, managers use a set of goals. Goals are also set in advance to keep each worker's exposure under certain levels and to minimize the number of workers involved. Goals are also set on the total cumulative personnel radiation exposure (man-rem) for each major job, for the entire overhaul or maintenance period, and for the whole year. These goals are deliberately made hard to meet in order to encourage personnel to improve performance.

Of the various goals used, the most effective in reducing personnel radiation exposure has been the use of radiation control levels which are lower than the Navy's quarterly and annual limits. Control levels in shipyards range from 0.5 rem to 2 rem for the year, depending on the amount of radioactive work scheduled, whereas 5 rem per year is the Navy limit.

To achieve the benefits of lower control levels in reducing total man-rem, it is essential to minimize the number of workers permitted to receive radiation exposure. Otherwise the control levels could be met merely by adding more workers. Organizations are required to conduct periodic reviews to ensure the number of workers is the minimum.

Following is a brief checklist which has been in use for years in maintaining personnel radiation exposure as low as reasonably achievable during maintenance, overhaul, and repair.

Preliminary Planning

- Plan in advance
- Delete unnecessary work
- Determine expected radiation levels

Preparation of Work Procedures

- Plan access to and exit from work area
- Provide for service lines (air, welding, ventilation, etc.)
- Provide communication (sometimes includes closed-circuit television)
- Remove sources of radiation
- Plan for installation of temporary shielding
- Decontaminate
- Work in lowest radiation levels
- Perform as much work as practicable outside radiation areas
- State requirements for standard tools
- Consider special tools
- Include inspection requirements (these identify steps where radiological control personnel must sign prior to work proceeding)
- Minimize discomfort of workers
- Estimate man-rem

Temporary Shielding

- Control installation and removal by written procedure
- Inspect after installation
- Conduct periodic radiation surveys
- Minimize damage caused by heavy lead temporary shielding
- Balance radiation exposure received in installation against exposure to be saved by installation
- Shield travel routes
- Shield components with abnormally high radiation levels early in the maintenance period
- Shield position worker occupies
- Perform directional surveys to improve design of shielding by locating sources of radiation
- Use mock-up to plan temporary shielding design and installation

Rehearsing and Briefing

- Rehearse
- Use mock-up duplicating working conditions
- Use photographs
- Brief workers

Performing Work

- Post radiation levels
- Keep excess personnel out of radiation areas
- Minimize beta radiation exposure (anticontamination clothing effectively shields cobalt 60 betas)
- Supervisors and workers keep track of radiation exposure
- Workers assist in radiation and radioactivity measurements

- Delegate radiological control monitoring responsibilities when necessary to minimize radiation exposure
- Evaluate use of fewer workers
- Reevaluate reducing radiation exposures

## Radiation Exposure Data

Radioactive materials had been handled in shipyards for years before Naval nuclear propulsion plant work started. Examples of such work include non-destructive testing using radiography sources and radiation instrument calibration using radioactive sources. Since this work is licensed by the Nuclear Regulatory Commission or by a state under agreement with the Nuclear Regulatory Commission, the radiation exposure from this licensed work has been excluded whenever practicable from this report.

Table 1 shows the dates when radioactive work associated with Naval nuclear propulsion plants started in each of eleven shipyards. Seven of these shipyards have constructed Naval nuclear-powered ships; however, little radiation exposure is received in new construction. The dates of starting reactor plant overhaul, therefore, are the significant dates for start of radioactive work.

Table 2 summarizes radiation exposure received in nuclear-powered ships and their supporting tenders and submarine bases since the first nuclear-powered ship went to sea in January 1955. Most of the radiation exposure in this table results from inspection, maintenance and repair work in the reactor compartments of ships. Radiation exposures for reactor compartment work increase as reactor plant radiation levels increase with the age of the plant.

As expected, the number of personnel monitored for exposure to radiation increased with the increasing number of nuclear-powered ships. Initially everyone aboard a nuclear-powered submarine was monitored for radiation exposure. After years of experience showed that personnel outside propulsion plant spaces received exposures indistinguishable from natural background, the number of personnel monitored for occupational exposure to radiation was sharply reduced in 1974. For example, in 1973 almost sixty percent of those monitored were recorded as receiving zero radiation exposure; as a result of reducing numbers of personnel monitored unnecessarily, less than ten percent are now recorded with zero exposure. Personnel outside propulsion plant spaces in submarines now wear dosimetry badges to verify they receive no occupational exposure.

Table 3 summarizes radiation exposures of shipyard personnel since the start of Naval nuclear propulsion plant radioactive work in 1954. Figure 2 shows graphically that total personnel radiation exposure has been reduced in shipyards even though the amount of work has increased. Since ship overhauls frequently overlapped calendar years, the numbers of ships in overhaul shown in Figure 2 were determined by dividing by 12 the total number of months each ship was in overhaul during a calendar year.

The increase in the numbers of personnel monitored and total man-rem exposure in the early years shows the increasing workload in reactor plant work as the number of ships was increased. By 1962 four submarine reactor plants had been overhauled and major efforts were underway to reduce radiation levels. By 1966 the number of ships in overhaul had quadrupled as indicated by the buildup to the peak in total man-rem. Subsequently, the number of ships in overhaul more than doubled again. Decreases in total annual exposures, numbers of personnel monitored, and numbers of personnel with annual exposures over 2 rem have been results of the program to reduce radiation exposures to the minimum practicable. The total annual exposure for the shipyards has averaged less than 6000 man-rem and for ships has averaged less than 2000 man-rem.

Since a worker usually is exposed to radiation in more than one year, the total number of personnel monitored cannot be obtained by adding the annual numbers. The total number of shipyard personnel monitored for radiation exposure associated with the Naval nuclear propulsion program has been about 118,000. Nearly all of these are civilians, almost half of whom are U. S. Government employees at six Naval shipyards. Table 4 provides further information about the distribution of their radiation exposures. In 1981, about 93 percent of those monitored for radiation in shipyards and about 99 percent of those in ships received less than 0.5 rem in a year, the limit allowed by Federal regulations for a member of the general public. The average exposure per year for each person monitored has been 0.33 rem in shipyards, which is less than one tenth the occupational exposure limit. The average exposure per year for those monitored in ships has been 0.12 rem, which is less than the average annual exposure a person receives from natural background and medical radiation.

Table 4 also lists the numbers of personnel who have exceeded the 3 rem quarterly exposure limit. In no case have personnel exceeded the accumulated limit of 5 rem for each year of age over eighteen. The total number of persons who have exceeded the quarterly limit since the limit was imposed in 1959 is 37, of whom 4 were military personnel aboard ships. Thirty of the 37 personnel had quarterly exposures in the range of 3 to 4 rem, and the highest exposure was 9.7 rem in a quarter. Navy procedures require any person who receives greater than 25 rem in a short time period to be placed under medical observation. None of the exposures reached this level.

The average lifetime accumulated exposure from radiation associated with Naval nuclear plants for all shipyard personnel is 1.4 rem. Since the average annual exposure per person is 0.33 rem, this means that the average shipyard radiation worker is monitored because of Naval nuclear propulsion plant work for about four years. The average lifetime accumulated exposure for the 54,000 Naval officers and enlisted men trained to

## TABLE 1

## SHIPYARD FIRST REACTOR PLANT OPERATION AND FIRST RADIOACTIVE OVERHAUL WORK

| Shipyard | Year First New Construction Reactor Started Operation | Year First Reactor Plant Overhaul Started |
|---|---|---|
| Electric Boat Division*<br>Groton, Connecticut | 1954 | 1957 |
| Portsmouth Naval Shipyard<br>Portsmouth, New Hampshire | 1958 | 1959 |
| Mare Island Naval Shipyard**<br>Vallejo, California | 1958 | 1962 |
| Pearl Harbor Naval Shipyard<br>Pearl Harbor, Hawaii | None | 1962 |
| Charleston Naval Shipyard**<br>Charleston, South Carolina | None | 1963 |
| Newport News Shipbuilding and Dry Dock Company<br>Newport News, Virginia | 1960 | 1964 |
| Bethlehem Steel Shipbuilding***<br>(Subsequently Electric Boat Division) Quincy, Massachusetts | 1961 | None |
| New York Shipbuilding Corporation***<br>Camden, New Jersey | 1963 | None |
| Norfolk Naval Shipyard<br>Norfolk, Virginia | None | 1965 |
| Puget Sound Naval Shipyard**<br>Bremerton, Washington | None | 1967 |
| Ingalls Shipbuilding Division<br>Pascagoula, Mississippi | 1961 | 1970 |

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* Electric Boat Division performed overhauls in 1957-1977 but only did new construction work again starting in 1978.

** Radioactive work of less extent than in an overhaul commenced in Mare Island in 1958, in Charleston in 1961, and in Puget Sound in 1965.

*** Work on Naval nuclear-powered ships was discontinued at Camden, New Jersey in 1967 and at Quincy, Massachusetts in 1969.

## TABLE 2
## OCCUPATIONAL RADIATION EXPOSURE RECEIVED BY PER[illegible]NEL ASSIGNED TO TENDERS, BASES, AND NUCLEAR-POWERED S[illegible] FROM OPERATION AND MAINTENANCE OF NAVAL NUCLEAR PROPUL[illegible] PLANTS

| | Number of Persons Monitored Who Received Exposures In The Following Ranges of Rem for the Year | | | | | | Total Personnel Monitored | Total Man-Rem |
|---|---|---|---|---|---|---|---|---|
| Year | 0-1 | 1-2 | 2-3 | 3-4 | 4-5 | >5* | | |
| 1954 | 36 | 0 | 0 | 0 | 0 | 0 | 36 | 8 |
| 1955 | 90 | 11 | 0 | 0 | 0 | 0 | 101 | 25 |
| 1956 | 108 | 10 | 4 | 0 | 0 | 0 | 122 | 50 |
| 1957 | 293 | 7 | 1 | 0 | 0 | 0 | 301 | 60 |
| 1958 | 562 | 11 | 3 | 0 | 0 | 0 | 576 | 100 |
| 1959 | 1057 | 41 | 8 | 3 | 0 | 0 | 1109 | 200 |
| 1960 | 2607 | 88 | 8 | 4 | 3 | 1 | 2711 | 375 |
| 1961 | 4812 | 106 | 31 | 4 | 4 | 0 | 4957 | 680 |
| 1962 | 6788 | 182 | 75 | 31 | 17 | 1 | 7094 | 1312 |
| 1963 | 9188 | 197 | 39 | 14 | 3 | 1 | 9442 | 1420 |
| 1964 | 10317 | 331 | 93 | 35 | 15 | 4 | 10795 | 1964 |
| 1965 | 11883 | 592 | 224 | 96 | 30 | 24 | 12849 | 3421 |
| 1966 | 18118 | 541 | 156 | 95 | 44 | 28 | 18982 | 3529 |
| 1967 | 21028 | 339 | 139 | 48 | 11 | 0 | 21565 | 3084 |
| 1968 | 24200 | 373 | 103 | 20 | 2 | 0 | 24698 | 2463 |
| 1969 | 26969 | 577 | 127 | 39 | 6 | 0 | 27718 | 2918 |
| 1970 | 26206 | 610 | 134 | 30 | 0 | 0 | 26980 | 3089 |
| 1971 | 26090 | 568 | 122 | 31 | 2 | 0 | 26813 | 3261 |
| 1972 | 33312 | 602 | 180 | 13 | 1 | 0 | 34108 | 3271 |
| 1973 | 30852 | 600 | 102 | 15 | 1 | 0 | 31570 | 3160 |
| 1974 | 18375 | 307 | 65 | 2 | 0 | 0 | 18749 | 2142 |
| 1975 | 17638 | 330 | 28 | 1 | 0 | 0 | 17997 | 2217 |
| 1976 | 17795 | 369 | 56 | 9 | 0 | 0 | 18229 | 2642 |
| 1977 | 20236 | 346 | 95 | 36 | 3 | 0 | 20716 | 2812 |
| 1978 | 22089 | 290 | 23 | 1 | 0 | 0 | 22403 | 2234 |
| 1979 | 21121 | 75 | 1 | 0 | 0 | 0 | 21197 | 1528 |
| 1980 | 21767 | 78 | 0 | 0 | 0 | 0 | 21845 | 1494 |
| 1981 | 23199 | 27 | 0 | 0 | 0 | 0 | 23226 | 1406 |

Note: Data obtained from summaries rather than directly from original medical records. However, it is expected that the large effort to compile comparable data from original medical records would show differences no greater than five percent. Total man-rem was determined by adding actual exposures for each individual during the year.

* Limit in the Naval nuclear propulsion program was changed to 5 rem per year in 1967

## TABLE 3
## OCCUPATIONAL RADIATION EXPOSURE RECEIVED BY SHIPYARD PERSONNEL FROM WORK ASSOCIATED WITH NAVAL NUCLEAR PROPULSION PLANTS

| Year | Number of Persons Monitored Who Received Exposure In The Following Ranges of Rem For The Year | | | | | | Total Personnel Monitored | Total Man-Rem |
|---|---|---|---|---|---|---|---|---|
| | 0-1 | 1-2 | 2-3 | 3-4 | 4-5 | >5* | | |
| 1954 | 508 | 9 | 3 | 5 | 3 | 0 | 528 | 64 |
| 1955 | 2563 | 80 | 25 | 6 | 3 | 2 | 2679 | 344 |
| 1956 | 2834 | 20 | 5 | 2 | 0 | 1 | 2862 | 162 |
| 1957 | 3473 | 97 | 31 | 1 | 2 | 4 | 3608 | 495 |
| 1958 | 5766 | 165 | 46 | 10 | 4 | 7 | 5998 | 779 |
| 1959 | 10388 | 221 | 133 | 78 | 49 | 23 | 10892 | 1864 |
| 1960 | 12047 | 198 | 97 | 22 | 4 | 0 | 12368 | 1158 |
| 1961 | 13383 | 198 | 91 | 44 | 14 | 3 | 13733 | 1241 |
| 1962 | 14411 | 642 | 366 | 247 | 146 | 108 | 15920 | 5222 |
| 1963 | 19164 | 446 | 159 | 71 | 34 | 28 | 19902 | 2725 |
| 1964 | 24044 | 804 | 445 | 215 | 144 | 41 | 25693 | 5678 |
| 1965 | 22630 | 2306 | 1314 | 814 | 618 | 525 | 28207 | 15829 |
| 1966 | 29490 | 2352 | 1623 | 1057 | 1139 | 513 | 36174 | 18804 |
| 1967 | 29853 | 2388 | 1563 | 1096 | 733 | 1 | 35634 | 13908 |
| 1968 | 30159 | 1344 | 773 | 496 | 279 | 0 | 33051 | 8719 |
| 1969 | 25672 | 1790 | 1080 | 753 | 375 | 0 | 29670 | 11077 |
| 1970 | 21182 | 2127 | 1382 | 740 | 492 | 0 | 25923 | 13084 |
| 1971 | 20041 | 1928 | 1066 | 650 | 240 | 0 | 23925 | 10616 |
| 1972 | 17514 | 1692 | 849 | 139 | 5 | 0 | 20199 | 7002 |
| 1973 | 13036 | 1403 | 604 | 203 | 6 | 0 | 15252 | 6083 |
| 1974 | 12587 | 1464 | 745 | 311 | 50 | 0 | 15157 | 7206 |
| 1975 | 12825 | 1116 | 598 | 82 | 42 | 0 | 14663 | 5285 |
| 1976 | 13042 | 1268 | 633 | 30 | 0 | 0 | 14973 | 5310 |
| 1977 | 13835 | 1277 | 586 | 25 | 0 | 0 | 15723 | 5199 |
| 1978 | 13700 | 1016 | 268 | 0 | 0 | 0 | 14984 | 3680 |
| 1979 | 15032 | 227 | 7 | 0 | 0 | 0 | 15266 | 2024 |
| 1980 | 15287 | 377 | 0 | 0 | 0 | 0 | 15664 | 2402 |
| 1981 | 17414 | 304 | 0 | 0 | 0 | 0 | 17718 | 2310 |

NOTE: Data obtained from summaries rather than directly from original medical records. However, it is expected that the large effort to compile comparable data from original medical records would show differences no greater than five percent. Total man-rem was determined by adding actual exposures for each individual during the year.

*Limit in the Naval nuclear propulsion program was changed to 5 rem per year in 1967.

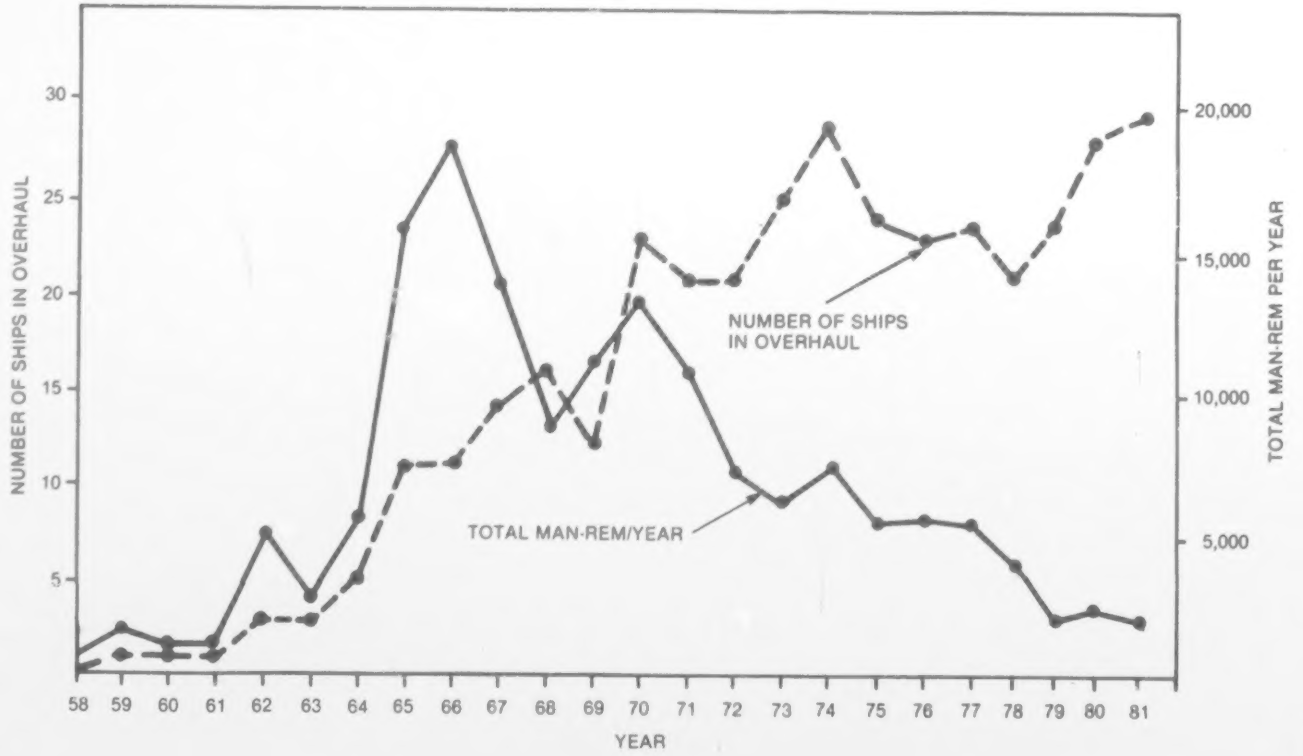

FIGURE 2

TOTAL RADIATION EXPOSURE RECEIVED BY SHIPYARD PERSONNEL
FROM WORK ASSOCIATED WITH NAVAL
NUCLEAR PROPULSION PLANTS 1958-1981

## TABLE 4
## SHIPYARD AND FLEET DISTRIBUTION OF PERSONNEL RADIATION EXPOSURE

| Year | Average Rem Per Person Monitored | | Percent of Personnel Monitored Who Received Greater Than 1 Rem | | Number of Personnel Who Exceeded 3 Rem/Quarter |
|---|---|---|---|---|---|
| | Fleet | Shipyard | Fleet | Shipyard | |
| 1954 | .22 | [illegible] | 0 | 3.8 | 0 |
| 1955 | .25 | .13 | 10.9 | 4.3 | 0 |
| 1956 | .41 | .06 | 11.5 | 1.0 | 0 |
| 1957 | .20 | .14 | 2.7 | 3.7 | 0 |
| 1958 | .17 | .13 | 2.4 | 3.9 | 0 |
| 1959 | .18 | .17 | 4.7 | 4.6 | 8 |
| 1960 | .14 | .09 | 7.5 | 2.6 | 0 |
| 1961 | .14 | .09 | 2.9 | 2.5 | 0 |
| 1962 | .18 | .33 | 4.3 | 9.5 | 9 |
| 1963 | .15 | .13 | 2.7 | 3.7 | 2 |
| 1964 | .18 | .22 | 4.4 | 6.4 | 4 |
| 1965 | .27 | .56 | 7.5 | 19.8 | 5 |
| 1966 | .19 | .52 | 4.6 | 18.5 | 6 |
| 1967 | .14 | .39 | 2.5 | 16.2 | 3 |
| 1968 | .10 | .26 | 2.0 | 8.8 | 0 |
| 1969 | .11 | .37 | 2.7 | 13.5 | 0 |
| 1970 | .11 | .50 | 2.9 | 18.3 | 0 |
| 1971 | .12 | .44 | 2.7 | 16.2 | 0 |
| 1972 | .10 | .35 | 2.3 | 13.3 | 0 |
| 1973 | .10 | .40 | 2.3 | 14.5 | 0 |
| 1974 | .11 | .48 | 2.0 | 17.0 | 0 |
| 1975 | .12 | .36 | 2.0 | 12.5 | 0 |
| 1976 | .14 | .35 | 2.4 | 12.9 | 0 |
| 1977 | .14 | .33 | 2.3 | 12.0 | 0 |
| 1978 | .10 | .24 | 1.4 | 8.5 | 0 |
| 1979 | .07 | .13 | 0.4 | 1.5 | 0 |
| 1980 | .07 | .15 | 0.4 | 2.4 | 0 |
| 1981 | .06 | .13 | 0.1 | 1.7 | 0 |
| Average | .12 | .33 | 2.4 | 11.2 | |
| NAVYWIDE AVERAGE | .23 | | 7.1 | | |

operate a nuclear propulsion plant is about 1 rem. These radiation exposures are much less than the exposure the average American receives from medical diagnostic X-rays during his working lifetime.

Table 5 provides information on the distribution of lifetime accumulated exposure for personnel assigned to tenders, bases and nuclear-powered ships. Typical lifetime exposures of shipyard personnel were discussed in ref (10). Table 5 includes all personnel who at some time in 1981 were monitored for radiation exposure. Federal radiation exposure limits allow accumulating 100 rem in twenty years of work, or 200 rem in forty years. The fact that no one shown in Table 5 comes close to having accumulated this much radiation exposure is the result of deliberate efforts to keep well below the lifetime accumulated radiation exposure limit.

TABLE 5
DISTRIBUTION OF TOTAL LIFETIME OCCUPATIONAL RADIATION EXPOSURE ASSOCIATED WITH NAVAL NUCLEAR PROPULSION PLANTS

| Range of Accumulated Lifetime Radiation Exposure (REM) | Percentage of Ship Personnel Monitored in 1981 With Lifetime Accumulated Radiation Exposure in the Radiation Range |
|---|---|
| 0 - 5 | 99.3 |
| 5 - 10 | 0.6 |
| 10 - 15 | 0.06 |
| 15 - 20 | 0.01 |
| 20 - 25 | 0.003 |
| 25 - 30 | 0 |
| 30 - 50 | 0 |
| Greater than 50 | 0 |

Table 6 provides a basis for comparison between the radiation exposure for light water reactors operated by the Navy and commercial power reactors licensed by the Nuclear Regulatory Commission. The 1980 data in this Nuclear Regulatory Commission table covers 68 licensees with a total of 53,796 man-rem (ref 11). The 1980 average annual exposure of each worker at commercial power reactors was 0.40 rem * Licensees of commercial power reactors reported 244 overexposures to external radiation during the years 1971 through 1980. Numbers in excess of 5 rem are not necessarily overexposures since Nuclear Regulatory Commission regulations permit exposures of 3 rem each quarter up to 12 rem per year within the accumulated total limit of 5 rem for each year of a person's age beyond eighteen.

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* This average was calculated by dividing total man-rem by total number of workers monitored as is done in Table 4. Ref (11) reports this value as 0.67; however it is calculated by dividing the total man-rem by the number of workers with measurable exposure.

## TABLE 6

PERSONNEL
RADIATION EXPOSURE FOR COMMERCIAL NUCLEAR-POWERED REACTORS LICENSED
BY U.S. NUCLEAR REGULATORY COMMISSION

SUMMARY OF ANNUAL WHOLE BODY EXPOSURE BY INCREMENT

| | | NUMBER OF INDIVIDUALS | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | EXPOSURE INCREMENT - REM | | | | | | | | | | | | Total Man-Rem | No. Of Over-Exposures |
| YEAR | TOTAL MONITORED | NOT MEASURABLE | 0-1 | 1-2 | 2-3 | 3-4 | 4-5 | 5-6 | 6-7 | 7-8 | 8-9 | 9-10 | >10 | | |
| 1969 | 2838 | 2607 | | | 134 | 65 | 25 | 5 | 2 | 0 | 0 | 0 | 0 | | |
| 1970 | 7509 | 6985 | | | 166 | 163 | 88 | 98 | 8 | 1 | 0 | 0 | 0 | | |
| 1971 | 9581 | 8996 | | | 315 | 137 | 105 | 17 | 11 | 0 | 0 | 0 | 0 | | 2 |
| 1972 | 15713 | 14783 | | | 532 | 199 | 111 | 46 | 21 | 9 | 6 | 6 | 0 | | 16 |
| 1973 | 33823 | 19043 | 9798 | 2468 | 1584 | 422 | 251 | 71 | 38 | 16 | 7 | 0 | 0 | 13963 | 19 |
| 1974 | 38938 | 20472 | 13766 | 2503 | 1378 | 471 | 226 | 86 | 30 | 6 | 0 | 0 | 0 | 13722 | 43 |
| 1975 | 44343 | 18852 | 18289 | 3948 | 1872 | 691 | 423 | 169 | 60 | 24 | 12 | 0 | 1 | 20879 | 14 |
| 1976 | 61151 | 25704 | 24606 | 4880 | 2354 | 789 | 487 | 188 | 70 | 26 | 11 | 5 | 1 | 26433 | 20 |
| 1977 | 67134 | 24868 | 31298 | 6162 | 2837 | 1130 | 569 | 141 | 66 | 36 | 21 | 6 | 0 | 32511 | 27 |
| 1978 | 76121 | 30143 | 34983 | 6405 | 2989 | 1080 | 418 | 67 | 26 | 8 | 0 | 0 | 2 | 31804 | 9 |
| 1979 | 109160 | 45087 | 50974 | 7934 | 3307 | 1251 | 477 | 86 | 28 | 13 | 2 | 0 | 1 | 39759 | 21 |
| 1980 | 133878 | 53547 | 61808 | 11474 | 4515 | 1537 | 686 | 192 | 98 | 18 | 3 | 0 | 0 | 53796 | 73 |

SOURCE: NUREG-0713, "Occupational Radiation Exposures at Commercial Nuclear Power Reactors 1980"

## INTERNAL RADIOACTIVITY

### Policy and Limits

The Navy's policy on internal radioactivity for personnel associated with the nuclear propulsion program continues to be the same as it was more than two decades ago—to prevent significant radiation exposure to personnel from internal radioactivity. The limits invoked to achieve this objective are one-tenth of the levels allowed by Federal regulations for radiation workers. The results of this program have been that no one has received more than one-tenth the Federal annual internal occupational exposure limits from internal radiation exposure caused by radioactivity associated with Naval nuclear propulsion plants.

The basic Federal limit for radiation exposure to organs of the body from internal radioactivity has been 15 rem per year. There have been higher levels applied at various times for thyroid and for bones; however, use of these specific higher limits has not been necessary in the Naval nuclear propulsion program.

Fifteen rem per year is the limit recommended for most organs of the body by the U. S. National Committee on Radiation Protection in 1954 (ref 1), by the U. S. Atomic Energy Commission in the initial edition of ref 3 applicable in 1957, by the International Commission on Radiological Protection in 1959 (ref 2), and was adopted for Federal agencies when President Eisenhower approved recommendations of the Federal Radiation Council May 13, 1960. Although the International Commission on Radiological Protection revised its recommendations in 1977 (ref 8) to raise limits for most organs, the Naval nuclear propulsion program has not changed its limits.

### Source of Radioactivity

Radioactivity can get inside the body through air, through water or food, and through surface contamination via the mouth, skin or a wound. The radioactivity of primary concern is the metallic corrosion products on the inside surfaces of reactor plant piping systems. These are in the form of insoluble metallic oxides, primarily iron oxides. Ref (12) contains more details on why cobalt 60 is the radionuclide of most concern for internal radioactivity.

The design conditions for reactor fuel are much more severe for warships than for commercial power reactors. As a result of being designed to withstand shock, naval reactor fuel elements retain fission products including fission gases within the fuel. Sensitive measurements are made frequently to verify the integrity of reactor fuel. Consequently, fission products such as strontium 90 and cesium 137 make no measurable contribution to internal exposure of personnel from radioactivity associated with Naval nuclear propulsion plants. Similarly, alpha emitters such as uranium and plutonium are retained within the fuel elements and are not accessible to personnel operating or maintaining a Naval nuclear propulsion plant.

Because of the high integrity of reactor fuel and because soluble boron is not used in reactor coolant for normal radioactivity control in Naval reactors, the amounts of tritium in reactor coolant are far less than in typical commercial power reactors. The small amounts that are present are formed primarily as a result of neutron interaction with the deuterium naturally present in water. The radiation from tritium is of such low energy that the Federal limits for breathing or swallowing tritium are one hundred times higher than for cobalt 60. As a result radiation exposure to personnel from tritium is far too low to measure. Similarly, the low energy beta radiation from carbon 14 does not add measurable radiation exposure to personnel operating or maintaining Naval nuclear propulsion plants.

## Control of Airborne Radioactivity

Airborne radioactivity is controlled in maintenance operations such that masks are not normally required. To prevent exposure of personnel to airborne radioactivity when work might expose radioactivity to the atmosphere, contamination containment tents or bags are used. The areas inside these containments are ventilated to the atmosphere through high efficiency filters which have been tested to remove at least 99.95 percent of particles of a size comparable to cigarette smoke. The occupied area outside these containments is required to be ventilated through high efficiency filters any time work which could cause airborne radioactivity is in progress inside an area such as a reactor compartment. Airborne radioactivity surveys are required to be performed regularly in radioactive work areas. Any time airborne radioactivity above the limit is detected in occupied areas, work which might be causing airborne radioactivity is stopped. This conservative action is taken to minimize internal radioactivity even though the Navy's airborne radioactivity limit would allow continuous breathing for forty hours per week throughout the year to reach an annual exposure to the lungs of one-tenth the Federal limit. Personnel are also trained to use masks when airborne radioactivity above the limit is detected. However, masks are seldom needed and are not relied upon as the first line of defense against airborne radioactivity.

It is not uncommon for airborne radioactivity above the limit to be caused by radon naturally present in the air. Atmospheric temperature inversion conditions can allow this buildup of radioactive particles from radon. Radon can build up above the limit in sealed or poorly ventilated rooms in homes or buildings made of stone. Most cases of airborne radioactivity above the limits in occupied areas in the Naval nuclear propulsion program have been caused by radioactive particles from radon and not from the reactor plant. Procedures have been developed to allow work to continue after it has been determined that the elevated airborne radioactivity is from naturally occurring radon.

Radon is also emitted from radium used for making dials luminous. There have been a number of cases where a single radium dial such as on a wristwatch has caused the entire atmosphere of a submarine to exceed the airborne radioactivity limit used for the nuclear propulsion plant. Radium in any form has been banned from submarines to prevent interference with keeping airborne radioactivity from the nuclear propulsion plant as low as practicable.

## Control of Radioactive Surface Contamination

Perhaps the most restrictive regulations in the radiological control program are established in the requirements for the control of radioactive contamination. Work operations involving potential for spreading radioactive contamination are planned using containment to prevent personnel becoming contaminated. The controls for radioactive contamination are so strict that precautions sometimes have had to be taken to prevent tracking contamination from fallout and natural sources into nuclear areas because the contamination control limits used in the nuclear areas were below the levels of fallout and natural contamination occurring outside in the general public areas.

Anticontamination clothing, including coveralls, hood (to cover the head, ears and neck), shoe covers and gloves, is provided when needed. However, the basic approach is to avoid the need for anticontamination clothing by containing the radioactivity. As a result, most work on radioactive materials is performed with hands reaching into gloves installed in containments, making it unnecessary for the worker to wear anticontamination clothing. In addition to providing better control over the spread of radioactivity, this method has reduced radiation exposure since the worker can usually do his job better and faster in his normal work clothing. A basic requirement of contamination control is monitoring all personnel leaving any area where radioactive contamination could possibly occur. Workers are trained to survey themselves, and their performance is checked by radiological control personnel. Personnel monitor before, not after, they wash. Therefore, washing or showering at the exit of radioactive work areas is not required. The basic approach is to prevent contamination, not wash it away.

Surveys for radioactive contamination are taken frequently by trained radiological control personnel. Results of these surveys are reviewed by supervisory personnel to provide a double-check that no abnormal conditions exist. The instruments used for these surveys are checked against a radioactive calibration source daily and prior to use, and they are calibrated at least every six months.

## Control of Food and Water

Smoking, eating, drinking and chewing are prohibited in radioactive areas. Aboard ship, drinking water is distilled from seawater by using steam. However, the steam is not radioactive because it is in a secondary piping system separate from the reactor plant radioactive water. In the event radioactivity were to leak into the steam system, sensitive radioactivity detection instruments which operate continuously would give early warning.

Wounds

Skin conditions or open wounds which might not readily be decontaminated are cause for disqualification from doing radioactive work. Workers are trained to report such conditions to radiological control or medical personnel, and radiological control technicians watch for open wounds when workers enter radioactive work areas. In the initial medical examination prior to radiation work and during subsequent examinations, skin conditions are also checked. If the medical officer determines a wound is sufficiently healed or considers the wound adequately protected, he may remove the disqualification.

There have been only a few cases of contaminated wounds in the Naval Nuclear Propulsion Program. In most years, none occurred. Examples of such injuries which have occured in the past include a scratched hand, a metallic sliver in a hand, a cut finger, and a puncture wound to a hand. These wounds occurred at the same time the person became contaminated. Insoluble metallic oxides which make up the radioactive contamination remain primarily at the wound rather than being absorbed into the blood stream. These radioactively contaminated wounds have been easily decontaminated. No case of a contaminated wound is known where the radioactivity initially present in the wound was as much as one one-thousandth of that permitted for a radiation worker to have in his body.

Monitoring for Internal Radioactivity

The radioactivity of most concern for internal radiation exposure from Naval nuclear propulsion plants is cobalt 60. Although most radiation exposure from cobalt 60 inside the body will be from beta radiation, the gammas given off make cobalt 60 easy to detect. Complex whole body counters are not required to detect cobalt 60 at low levels inside the body. For example, one millionth of a curie of cobalt 60 inside the lungs or intestines will cause a measurement of two times above the background reading with a standard radiation survey instrument. This amount of internal radioactivity will cause the instrument used to monitor personnel for radioactive contamination on their body to reach the alarm level. Every person is required to monitor his entire body every time he leaves an area with radioactive surface contamination. Monitoring the entire body is a requirement in the Naval nuclear propulsion program; monitoring just hands and feet is not permitted. Therefore, if a person had as little as a millionth of a curie of cobalt 60 inside him, it would readily be detected.

Swallowing one millionth of a curie of cobalt 60 will cause internal radiation exposure of about 0.06 rem. The radioactivity will pass through the body and be excreted within a period of a little more than one day.

One millionth of a curie of cobalt 60 deposited in the lungs as a result of an inhalation incident is estimated to cause a radiation exposure of about 3 rem to the lungs over the following year based on standard calculational techniques recommended by the International Commission on Radiological Protection, (ref 13). These techniques provide a convenient way to estimate the amount of radiation exposure a typical individual might be expected to receive from small amounts of internally deposited radioactivity. These techniques account for the gradual removal of cobalt 60 from the lungs through biological processes and the radioactive decay of cobalt 60 with a 5.3 year half life. However, if an actual case were to occur, the measured biological elimination rate would be used in determining the amount of radiation exposure received.

In addition to the control measures to prevent internal radioactivity and the whole body monitoring frequently performed on those who work with radioactive materials, more sensitive monitoring is also performed during radioactive overhaul work. Shipyard procedures for monitoring internal radioactivity use the type of scintillation detectors which will reliably detect an amount of cobalt 60 inside the body that is more than one hundred times lower than the one millionth of a curie used in the examples above. Shipyards typically monitor for internal radioactivity as part of each radiation medical examination, performed before an employee initially performs radiation work, after he terminates radiation work, and periodically in between. Shipyards also monitor periodically during the year groups of personnel who did the work most likely to have caused spread of radioactive contamination. Any person who has radioactive contamination above the limit anywhere on the skin of his body during regular monitoring at the exit from a radioactive area is monitored for internal radioactivity with the sensitive detector. Also any person who might have breathed airborne radioactivity above limits is monitored with the sensitive detector.

## Results of Internal Monitoring in 1981

During 1981, over 10,000 personnel were monitored for internally deposited radioactivity using sensitive scintillation detectors at the nine shipyards performing work associated with Naval nuclear propulsion plants. Equipment and procedures provide detection levels at least one hundred times lower than one-millionth of a curie. One person had internal radioactivity above this level. He had 0.014 millionths of a curie in his gastrointestional system and 0.009 millionths of a curie in his lungs; the radionuclide was insoluble cobalt 60. After three days, the quantity of internally deposited radioactivity had decreased to less than 0.01 millionth of a curie due to elimination by natural biological processes. The individual received 1.3 mrem to his lower large intestines as the radioactivity passed through his gastrointestinal system and will receive approximately 14 mrem to his lungs over his lifetime.

## EFFECTS OF RADIATION ON PERSONNEL

Control of radiation exposure in the Naval nuclear propulsion program has always been based on the assumption that any exposure, no matter how small, involves some risk; however, exposure within the accepted exposure limits represents a risk small compared with normal hazards of life. The basis for this statement is presented below.

### Exposure to Radiation Involves Some Risk

Since the inception of nuclear power, scientists have cautioned that exposure to ionizing radiation in addition to that from natural background involves some risk. The National Committee on Radiation Protection and Measurements in 1954 (ref 1) and the International Commission on Radiological Protection in 1958 (ref 2) both recommended that exposures should be kept as low as practicable and that unnecessary exposure should be avoided to minimize this risk. The International Commission on Radiological Protection in 1962 (ref 14) explained the assumed risk as follows:

> "The basis of the Commission's recommendations is that any exposure to radiation may carry some risk. The assumption has been made that, down to the lowest levels of dose, the risk of inducing disease or disability in an individual increases with the dose accumulated by the individual, but is small even at the maximum permissible levels recommended for occupational exposure."

The National Academy of Sciences-National Research Council Advisory Committee on the Biological Effects of Atomic Radiation included similar statements in its reports in the 1956-1961 period. In 1960, the Federal Radiation Council stated in ref 4 that its radiation protection guidance did not differ substantially from recommendations of the National Committee on Radiation Protection and Measurements, the International Commission on Radiological Protection, and the National Academy of Sciences.

One conclusion from these reports is that radiation exposures to personnel should be minimized. This is not a new conclusion. It has been a major driving force of the Naval nuclear propulsion program.

### Studies of the Effects of Radiation on Humans

Tens of thousands of reports have been written on the effects of radiation. Even the list of summary reports is voluminous. In spite of the fact that there are many unanswered questions concerning the effects of radiation on humans, more is known about radiation than almost any substance that can affect humans. More money has been spent to learn the effects of radiation on humans than for any other hazard in our modern society. In fact, the National Academy of Sciences in ref 15 stated: "It is fair to say that we have more scientific evidence on the hazards of ionizing radiation than most, if not all, other environmental agents that affect the general public."

The main effect is cancer. Effects other than cancer have not been found for low-level radiation exposure to adults. The following brief summary of the effects of low-level whole body external radiation is primarily from refs 15 and 16.

The most important data on the effects of whole body external radiation exposure on humans comes from the almost 30 years of extensive study of the Japanese atomic bomb survivors. In addition, studies have been made of the Marshall Islands inhabitants who received about 12,000 man-rem from fallout in 1954. Studies have been made on groups of patients who have had frequent diagnostic x-ray examinations. Numbers of studies have been made on patients who have had radiation therapy for a disease of the bones of the back and for other conditions. These studies predominantly involved radiation doses of greater than 100 rem. The determinations of damage from doses greater than 100 rem have been reasonably consistent from numerous different studies. Extensive irradiation studies of animals have also been used to show what to look for in humans. These animal studies also show under controlled conditions not available in studies on humans how the radiation effects change with amount and frequency of radiation exposure.

Results of radiation studies on humans show the highest rates of cancer occur in the thyroid and the female breast, although the death rate for thyroid cancer is low. The cancer rates from radiation are lower for leukemia and lung cancer, and lower still for cancers of the bone and other organs. Leukemia has been associated with radiation exposure in almost every study of radiation on humans. Reasons for this include the improved diagnosis of leukemia in recent decades and the low natural incidence of leukemia compared to other cancers. However one type of leukemia, chronic lymphatic leukemia, has not been found in any study to be associated with radiation. Some organs appear to be so resistant to radiation-induced cancer that there has been no clear association between radiation and cancer in these organs. One example is the prostrate gland.

One characteristic of cancer caused by low-level radiation is the long delay time between time of radiation exposure and time of diagnosis of cancer. Cancer is not diagnosed until more than a few years have elapsed. In the Japanese atomic bomb survivors, the end of the latent period for leukemia was about 25 years. For the sum of all types of cancers, ref 16 assumes that in 25 years one-half the cancers will have occurred.

Cataracts of the eyes can be caused by radiation. However, cataract formation appears to have more evidence of having a threshold radiation dose than any other radiation damage studied. Very high radiation doses have been required to produce cataracts. Ref 15 states that single exposures of 200 to 500 rem or fractionated exposures of 1000 rem are the threshold exposures required to produce damage to the lens of the eye sufficient to interfere with vision.

Genetic effects can also be caused by radiation. However, genetic effects greater than the natural incidence rate have not been demonstrated in human populations exposed to radiation. Genetic effects are changes in human genes that do not pose a risk to the parent but could cause birth defects in offspring. The current natural rate of genetic effects is approximately 10 percent of all live births and range from trivial effects, such as hair and eye color changes, to more serious disorders. No increase in the natural rate of genetic effects has been found in studies of the 35,000 children conceived by parents irradiated as a result of the nuclear explosions in Hiroshima or Nagasaki in 1945.

Sterility, which is not a genetic effect, can be caused by radiation. However, according to ref 15, the radiation exposure required to cause sterility in males is very high, probably in excess of lethal exposures. Scientific reports of several decades ago speculated that radiation might cause a general effect that would shorten life, similar to aging. Reports in the last decade conclude such an effect has not been found in studies on humans. Nor have numerous other diseases such as heart disease been associated with radiation in these studies. To date the chief effect of radiation on humans has been found to be cancer.

In 1980, the National Institute for Occupational Safety and Health issued a report (ref 17) concerning the health of Portsmouth Naval Shipyard workers.

In 1978, Dr. T. Najarian, assisted by the Boston Globe, issued a sensationalized report which alleged that Portsmouth Naval Shipyard (PNS) workers who were occupationally exposed to low-level radiation suffered twice the expected rate of overall cancer deaths and five times the expected rate of leukemia deaths. This report was based on an informal review of several hundred death records, without any official input. It caused a number of frightening news stories. NIOSH was subsequently directed by Congress to investigate Dr. Najarian's report.

Under contract with NIOSH, Dr. Najarian's study was repeated using data the Navy made available to NIOSH. In June 1979, Dr. Najarian testified before Congress on the results of the reanalysis based on official data. In his testimony Dr. Najarian repudiated his earlier findings of increased overall cancer and leukemia. His third finding of increased blood cancers was separately repudiated at that time by the National Cancer Institute.

In December 1980, NIOSH finished their investigation based on approximately 25,000 Portsmouth Naval Shipyard workers and issued a final report. This report states that NIOSH found no excess of deaths due to leukemia or other cancers among the Shipyard workers. This report specifically states:

> "No relationship between exposure to radiation and mortality from any cause was observed among the PNS population when compared to the United States white male population. Furthermore, no excess in leukemia mortality was observed in the radiation exposed population when compared to the non-radiation exposed employees of PNS."

Thus, the earlier reports of excess cancer rates among Portsmouth Naval Shipyard workers exposed to low-level radiation were not substantiated by NIOSH.

The Department of Energy is sponsoring a more comprehensive shipyard epidemiologic study. The study is being performed by Johns Hopkins University and will include radiation workers in all shipyards doing Naval nuclear propulsion plant work so that its findings will be based on a much larger population. Because of the size of the study, results are not expected for several years.

## Numerical Estimates of Risk from Radiation

In 1972, both the United Nations Scientific Committee on the Effects of Atomic Radiation and the National Academy of Sciences-National Research Council Advisory Committee on the Biological Effects of Ionizing Radiations issued reports (refs 18 and 19) which estimated numerical risks for specific types of cancer from radiation exposure to humans. In 1977, both the International Commission on Radiological Protection and the United Nations Scientific Committee on the Effects of Atomic Radiation issued reports (refs 8 and 16) reconfirming these risk estimates. The risk estimates from both refs 8 and 16 can be briefly summarized as follows:

> In a large population group (such as 100,000 people) receiving an annual total of 10,000 man-rem year after year, the increased risk from this radiation appears to be in the region of about one fatal cancer case each year and about one leukemia case every five years in excess of the normal numbers of cases.

This can be used to develop a risk estimate for personnel exposed to radiation associated with Naval nuclear propulsion plants. In all shipyards there have been a total of about 118,000 personnel monitored for exposure to radiation, and their exposure rate has averaged less than 6,000 man-rem per year. Therefore, there should be less than one excess fatal cancer per year and less than one excess leukemia case every five years among the total 118,000 shipyard personnel who have ever been monitored for radiation associated with Naval nuclear propulsion plants.

According to refs 8 and 16, this risk estimate is likely to be substantially overstated because the radiation exposures are from gamma radiation at low doses and low dose rates. Also, exposure to neutrons and exposure from internal radioactivity in the Naval nuclear propulsion program are too low to have the confusing effects noted in some studies of the effects of radiation on humans. The National Academy of Sciences-National Research Council Committee on Biological Effects of Ionizing Radiation issued a report in 1980 (ref 15) which also stated that the risk estimates in refs 8 and 16 for low-level exposure may be overestimated. This report recommended that the risk of dying of cancer from low-level radiation exposure be estimated based on a model which yields lower risk estimates than those reported in refs 8 and 16. For simplicity, the discussion which follows will use the earlier conservative estimates in refs 8 and 16.

Radiation exposure received by Naval personnel assigned to nuclear-powered ships and their support facilities has averaged less than 2000 man-rem per year. Therefore, according to refs 8 and 16 there should be less than one excess fatal cancer every five years and less than one excess leukemia case every twenty-five years among the approximately 54,000 Naval personnel who have ever been monitored for occupational exposure to radiation associated with Naval nuclear propulsion plants. Since only a few percent of the total man-rem to ship personnel is from neutrons, the same qualifications apply as were mentioned for shipyard personnel, and this risk estimate is likely to be substantially overestimated.

## Radiation Exposure Comparisons

To help put this risk estimate in perspective, comparisions are needed. For example, in a typical group of 10,000 people in the U. S., a total of 1600 will die of cancer (ref 20). If each of the 10,000 received over his lifetime one rem more than he was already receiving from background and medical sources, then according to the preceding risk estimate one extra person would die of cancer. Therefore, the 1600 cancer deaths would increase to 1601 for this group of 10,000. This example is directly applicable to the Naval nuclear propulsion program where the average lifetime occupational radiation exposure is one rem.

However, a few highly controversial studies have concluded that more people would die from radiation than the National Academy of Sciences and United Nations committees predict. If the higher risk estimate of one well known study is applied to the same population group of 10,000, then the 1600 cancer deaths would increase to 1610.

The current controversy over effects of low-level radiation is whether one extra rem to each of 10,000 people will cause the normal number of 1600 cancer deaths to increase to 1601, or to 1610. The 1601 figure is the current best estimate. Studies are now underway to attempt to refine the accuracy of the estimates.

The following examples give further perspective on what radiation exposure means:

- Of all industrial and medical radiation workers in the United States, about 15,000 die each year from cancer. It is estimated that only 25 additional cancer deaths occur per year as a result of radiation exposure from their work.

- Radiation from the nuclear accident at Three Mile Island may add one fatal cancer death to the public within fifty miles. Of the two million people living within this fifty mile radius, more than 300,000 are expected to die of cancer from causes other than the radioactivity released from this accident.

- The average occupational radiation exposure of all those monitored in the Naval nuclear propulsion program is about 0.23 rem per year. This is only slightly greater than the average radiation exposure received in the U. S. each year from natural background and medical x-rays. (Derived from ref 21).

- The average lifetime occupational radiation exposure of one rem for personnel in the Naval nuclear propulsion program is less than one tenth the amount of radiation exposure these same personnel will average over their lifetimes from natural background and medical x-rays. (Derived from ref 21).

- This one rem average lifetime occupational radiation exposure can also be compared very roughly to the 5 rem received in a year from smoking one pack of cigarettes per day. This comparison is not exact because it requires more lung exposure from natural radioactivity in tobacco to cause the same amount of risk as whole body gamma radiation. (ref 22)

- The risk of dying from an automobile accident is forty or more times higher than the risk of fatal cancer for the average person with 1 rem lifetime radiation exposure.

The total occupational radiation exposure of 3716 man-rem received by all personnel in the Naval nuclear propulsion program in 1981 can be compared to the many other sources of radiation exposure received by the U. S. population. Examples follow:

- 20,000,000 man-rem to the population of the U. S. each year from natural background radiation (ref 21).

- 17,000,000 man-rem to the population of the U. S. each year from medical and dental radiation (ref 21).

- 650,000 man-rem to the population of the U. S. each year from radioactivity in natural gas used for cooking (ref 22).

- 100,000 man-rem the one million inhabitants of Denver could save each year if they moved to a region such as Washington, D. C. with lower natural background radiation levels (Derived from ref 21 ).
- 12,000 man-rem total to passengers in jet airplane flights in the United States from increased cosmic radiation at the higher altitudes used by jets (ref 23).

Thus, the total occupational radiation exposure received by all personnel in 1981 is less than one ten-thousandth of the total radiation exposure received by the U. S. population from all sources. The risk from occupational radiation exposure in the Naval nuclear propulsion program is also less than the risks these same personnel face from natural background radiation or from medical radiation. To demonstrate this, the 118,000 personnel monitored for radiation in all shipyards over the last 28 years will receive about 11,800 man-rem per year from natural background and about the same from medical radiation. The average occupational exposure to this group has been less than 6,000 man-rem per year.

Risk estimates for radiation should also be compared to other risks normally encountered in industrial activities, using the following table for example:

DEATH RATES IN U. S. FOR VARIOUS CAUSES

| CAUSE | ANNUAL DEATHS PER 100,000 POPULATION |
|---|---|
| Smoking (ref 24 ) | 150 |
| Motor Vehicle accidents (ref 25 ) | 22 |
| Work accidents (ref 25 ) | |
| Mining, quarrying | 63 |
| Construction | 57 |
| Agriculture | 54 |
| Transportation and Public Utilities | 31 |
| All Industries Average | 14 |
| Government | 11 |
| Services | 9 |
| Manufacturing | 9 |
| Trade | 6 |
| Industrial accidents in a Naval Shipyard (eight shipyards 1972-1977) | 7 |
| Commercial air travel (ref 25 ) | 1 |
| Coal-fired electric power (estimate derived from ref 26 ) | 1 to 10 |
| Radiation associated with Naval Nuclear propulsion plants (risk estimate) | Less than 1 |

Because of these estimates on the risk of low-level radiation, extra hazard pay for radiation work has never been paid in the Naval nuclear propulsion program. Civil Service Commission regulations do not provide for hazard pay for radiation work. A serious disadvantage to extra pay for radiation risks is that it would tend to increase the difficulty in minimizing radiation exposure because some personnel would press for more radiation to maximize their pay.

## Extrapolations

In radiation, as in other areas, a most effective way to frighten people is to proclaim that no one knows what the effects are. This has been repeated so often that it has almost become an article of faith that no one knows the effects of low-level radiation on humans.

One could well state, "No one knows the risks of smoking a few cigarettes," but the risks of smoking a large number of cigarettes are well known. If 10,000 people smoke an average of four cigarettes a day, about 100 deaths will result; data are not available for lower smoking rates. For radiation, doses of 100 rem to each of 10,000 people would be required to cause an equal number of deaths. The effects of radiation on humans at doses of 100 rem are well known. The controversy over radiation risks today is how to extend the risk estimates to even lower levels. As we get to lower levels, it becomes more and more difficult to detect the effects, and this becomes a problem.

The figures just presented can be extended to show that one rem has about the same risk of death as smoking one cigarette per month. This comparison is only to show that finding out the effect on the death rate of one rem of exposure is about the same as trying to find out the effect of smoking one cigarette a month.

In summary, the effect of one rem is extremely small. There are physical limits to how far scientists can go to ascertain precisely the size of this risk, but it is known to be small. Instead of proclaiming how little is known about low-level radiation, it is more appropriate to emphasize how much is known about the small actual effects.

## Conclusions on the Effects of Radiation on Personnel

This perspective provides a better position to answer the question, "Is radiation safe?" If safe means zero effect, then the conclusion would have to be that radiation is unsafe. But to be consistent, background radiation and medical radiation would also have to be considered unsafe. Or more simply, being alive is unsafe.

"Safe" is a relative term. Comparisons are necessary for actual meaning. For a worker, safe means the risk is small compared to other risks accepted in normal work activities. Aside from work, safe means the risk is small compared to other risks routinely accepted in life.

Each recommendation on limits for radiation exposure from the key organizations referenced has emphasized the need to minimize radiation exposure. Thus, the Navy is committed to keeping radiation exposure to personnel as low as reasonably achievable. No level of radiation exposure has been identified for which responsible organizations have stated there is no effect. Similarly it is difficult to find a single activity of man for which one can confidently state the risk is zero. However, the above summaries show that the risk from radiation exposure associated with Naval nuclear propulsion plants is low compared to hazards normally accepted in industrial work and in daily life outside of work.

## CLAIMS FOR RADIATION INJURY TO PERSONNEL

Personnel who consider they have or might have had occupational injury are encouraged to file claims. The compensation systems make allowance for the long latent period for radiation-induced cancer. Naval shipyard personnel are employees of the U. S. Government and therefore file claims with the U. S. Department of Labor's Office of Workmen's Compensation. Shipyards hold no hearing on injury claims. They are not handled in an adversary procedure. The Navy has no rights to present a case to the Labor Department. The claim does not even have to be filed through the shipyard. The shipyard is not permitted to appeal a decision, but the employee may appeal. The primary consideration in the Federal laws and procedures set up for injury compensation is to take care of the Federal employee. The program to compensate Federal employees is well publicized.

In private shipyards injury compensation claims are handled under the Longshoreman's and Harbor Workers' Compensation Act. The claim may be handled through the shipyard's insurance carrier or by a U. S. Department of Labor claims examiner. Either the employee or the employer may appeal.

Claims for military personnel concerning prior duty are handled through the Veterans Administration.

There have been a total of 114 claims filed for injury from radiation associated with Naval nuclear propulsion plants. Eighty-nine originated from employees of the six Naval shipyards, twenty-three from private shipyards and two from Navy personnel. These claims are summarized in Table 7. As shown in Table 7 more than half the claims have been filed for injuries other than cancer or leukemia. Two-thirds of the claims filed for cancer or leukemia involved workers with lifetime radiation exposures less than the 5 rem a nuclear worker is permitted to receive in one year by Federal Regulations.

Two suits have been filed in court alleging injury from radiation. Neither person claims cancer. One was dismissed in 1979 and the other is still in litigation.

Five claims have been awarded, two for leukemia in 1968 and 1979 and three for cataracts of the eyes in 1971, 1974 and 1977. The Navy considers all five of these awards were incorrect:

- One leukemia case had an occupational exposure of 5.38 rem. The claimant had also received hundreds of rem in medical radiation exposure for adenoids. If radiation were to be selected as the cause of this leukemia, then the occupational exposure could not have been more than a tiny part of the total radiation exposure.
- The second leukemia case had a total occupational exposure of 1.00 rem. This amount of radiation exposure is small and less than 10 percent of the amount of exposure the claimant will receive during his life from natural background and medical radiation.

- Two of the cataract cases had total lifetime radiation exposures of about 3 rem, and one case had less than 1 rem. These exposures are hundreds of times smaller than needed to produce cataracts in the eyes.

From the radiation injury claims filed to date, the Navy has been unable to draw any conclusions concerning radiation injury to personnel occupationally exposed to radiation associated with Naval nuclear propulsion plants.

TABLE 7

CLAIMS FOR RADIATION INJURY TO PERSONNEL

| Injury Claimed | Claims Filed | Claims Awarded | Claims Denied or Deferred | Claims Active |
|---|---|---|---|---|
| Leukemia | 22 | 2 | 11 | 9 |
| Cancer Other Than Leukemia | 30 | 0 | 21 | 9 |
| Other | 62 | 3 | 37 | 22 |
| Total | 114 | 5 | 69 | 40 |

## AUDITS AND REVIEWS

Checks and cross-checks and audits and inspections of numerous kinds have been shown to be essential in maintaining high standards of radiological control. First, each worker is specially trained in radiological control as it relates to his own job. Second, written procedures exist which require verbatim compliance. Third, radiological control technicians and their supervisors oversee radioactive work. Fourth, personnel independent of radiological control technicians are responsible for personnel radiation exposure records.

Fifth, a strong independent audit program is required covering all radiological control requirements. In all shipyards this radiological audit group is independent of the radiological control organization and its findings are reported regularly to senior shipyard management, including the shipyard commander. This group performs continuing surveillance of radioactive work. It conducts in-depth audits of specific areas of radiological control. This group checks all radiological control requirements at least annually.

Sixth, the U. S. Department of Energy assigns to each shipyard a representative who reports to the Deputy Assistant Secretary for Naval Reactors at headquarters. One assistant to this representative is assigned full time to audit radiological controls, both in nuclear-powered ships and in the shipyard. Seventh, Naval nuclear propulsion program headquarters personnel conduct periodic inspections of radiological control in each shipyard. Similarly, there are multiple levels of audits and inspections for the other Naval shore facilities, tenders, and nuclear-powered ships.

## ABNORMAL OCCURRENCES

It is a fact of human nature that people make mistakes. The key to a good radiological control program is to find the mistakes while they are small and prevent the combinations of mistakes that lead to accidents. The preceding section on inspections supports the contention that more attention is given to errors and their prevention in the Naval nuclear propulsion program than to any other single subject. Requiring constant focus on improving performance of radiological work has proven effective in reducing errors.

In addition, radiological control technicians are authorized and required to stop anyone performing work in a manner which could lead to radiological deficiencies. A deficiency, of course, is failure to follow a written procedure verbatim. However, the broadest interpretation of the term "deficiency" is used in the Navy's radiological control program. Anything involved with radiation or radioactivity which could have been done better is also a radiological deficiency.

Radiological deficiencies receive management attention. But there is a higher level of deficiency that is defined as a radiological incident. Incidents attract a great deal of notice, including the personal attention of the Deputy Assistant Secretary for Naval Reactors at headquarters. Improvement programs over the years have constantly aimed at reducing the numbers of radiological incidents. As improvements occurred, the definition of what constituted an incident was changed to define smaller deficiencies as incidents. These changes were necessary so that the incident reporting system would continue to play a key role in upgrading radiological controls. As a result, it is not practicable to measure performance merely by counting numbers of radiological incidents or deficiencies.

There is a reporting system that has been nearly constant over time and therefore can be used as a basis for comparison. The Department of Energy and its predecessors have used these levels of severity to define radiological occurrences (ref 27). Examples of radiation exposure incidents in each type follow:

- Type A - external radiation exposure over 25 rem in one incident
- Type B - external radiation exposure over 5 rem in one incident
- Type C - external whole body radiation exposure over 3 rem in one quarter year

The Nuclear Regulatory Commission also has criteria defining abnormal occurrences. The Navy regularly evaluates radiological events using these criteria for comparison; results are reported in Table 8.

## TABLE 8

## ABNORMAL OCCURRENCES IN THE NAVAL NUCLEAR PROPULSION PROGRAM

| Year | Number of Abnormal Occurrences* |
|---|---|
| 1975 | 0 |
| 1976 | 0 |
| 1977 | 0 |
| 1978 | 0 |
| 1979 | 0 |
| 1980 | 0 |
| 1981 | 0 |

*Abnormal occurrences are reported here if the Navy evaluation determines they meet either the Department of Energy criteria for Type A radiation exposure incidents or the Nuclear Regulatory Commission criteria for quarterly report to Congress as abnormal radiation exposure occurrences.

The policy of the Navy is to provide for close cooperation and effective communication with state radiological officials involving occurrences that might cause concern because of radiological effects associated with the ships or shore facilities. The Navy has reviewed radiological matters with state radiological officials in the states where Naval nuclear-powered ships are based or overnauled. Although there were no recent occurrences which resulted in radiological effects to the public outside these facilities or which resulted in radiological injury to residents of the states working inside these facilities, states were notified when inquiries showed public interest in the possibility such events had occurred.

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Senator **Warner.** Admiral McKee, you have been at sea in submarines for nearly 18 years. You were in charge of training reactor operators under Admiral Rickover; you have been Superintendent of the Naval Academy. With that background you are uniquely qualified to comment on the caliber of personnel manning our nuclear ships and the effectiveness of their training. Please tell us—how good are the people operating these ships? Is the extensive emphasis on training to operate the propulsion plant resulting in officers that are better engineers than submarine commanders?

Admiral **McKee.** As Superintendent of the Naval Academy, I had a chance to get to know the midshipmen that enter our program and to look at their motivation. Quality people are still attracted to the nuclear navy for the same reason I got into the submarine field—the high caliber of people involved.

The ships in the nuclear navy and the men who serve in and on them are good. It is up to us in uniform to create an environment that makes them proud of what they are doing and makes them enthusiastic about it.

Historically in the submarine force, the No. 3 job in the submarine has been the engineer. The same emphasis on engineering exists today, but in order to rise to command of a submarine, one must be proficient in each department—engineering, weapons, navigation, and operations. I don't believe there is an overemphasis of engineering aspects in the submarine force.

RESTRICTED DATA

Senator **Warner.** I have enjoyed our brief hearing this morning. I think the brevity speaks of the confidence that I and other members of the committee have in you as an individual.

Without further ado, we will come to a close. I wish you luck during the coming year. Please feel free at any time to come over and talk with me about any situation you think merits our joint attention.

Admiral **McKee.** Thank you, sir.

[Questions with answers supplied follow:]

### QUESTIONS SUBMITTED BY SENATOR JOHN W. WARNER; ANSWERS SUPPLIED BY HERMAN E. ROSER

#### STOCKPILE IMROVEMENT ROGRAM

Senator **Warner.** [Deleted.]

Mr. **Roser.** [Deleted.]

#### BUYING DC-9'S

Senator **Warner.** I note that you are planning to buy two DC-9 aircraft. Why does DOE need its own Air Force?

Mr. **Roser.** The fiscal year 1983 budget includes $5.9 million to buy out the lease of two DC-9 aircraft. These aircraft are required for the transport of classified and/or hazardous materials and for the support of the operations at the Tonopah Test Range.

Senator **Warner.** Have you attempted to get dedicated aircraft from the Air Force?

Mr. **Roser.** In the past, we have attempted to utilize the services of the Military Airlift Command. These attempts were unsuccessful because of the Command's policies regarding services provided to others and their consequent inability to provide dependable, dedicated support.

Senator **Warner**. Is ownership cheaper than leasing?

Mr. **Roser**. The lease agreements for the two D-9's contain purchase options. The point has been reached in the term of the agreements where the cost of exercising the purchase options is less than continuing the lease agreements to full term.

### INERTIAL CONFINEMENT FUSION PROGRAM (ICF)

Senator **Warner**. Your ICF program has suffered in recent years from wildly fluctuating budgets. You have started facilities and then scaled them back. Last year you cut operating expenses in half. The Congress has expressed its support over the years for the three major efforts underway—one at each lab. It is about time to stop whip-sawing this program and get it on an even keel. What do you think should be the broad objectives of this ICF program?

Mr. **Roser**. Broadly speaking, our objective for ICF is to apply this in a practical way to simulate in the laboratory some of the physics and the effects of nuclear devices. In doing that we think the laboratories will also establish whether or not ICF is scientifically feasible as a potential energy source. Our judgment is that we are not warranted in the next few years in devoting money and effort to specific activities which address only the energy question. Instead the ICF program will concentrate on supporting the broad nuclear weapon development mission of the laboratories. We have reached something of a consensus within the community, including both the DOE laboratories and the supporting ones. It is that we can be ready in the late 1980's to evaluate the future directions of the program by operating the three major facilities. We feel we are much nearer to being on an even keel with ICF as a result of these adjustments in the direction of the program.

Senator **Warner**. Are you satisfied that the level of funding in the fiscal year 1983 budget is sufficient to meet those objectives?

Mr. **Roser**. Yes. At the requested budget levels, even though somewhat smaller than previous years, we feel that we will be able to effectively conduct this program until some of the major facilities are complete. At that time, we will request additional resources to assure effective operation of the new facilities.

### LOADS WARHEAD

Senator **Warner**. How much money is in your budget for a warhead for the BMD LoAD System?

Mr. **Roser**. Project 83-D-134, Low Altitude Defense System (LoADS) warhead production facilities, various locations, was included in the President's fiscal year 1983 amended congressional budget request. The total estimated cost of the project is $97.6 million. We are requesting $16.3 million in fiscal year 1983 to start this project. This requested fiscal year 1983 funding will be used for design of new buildings, building modifications, and utility services. It would also initiate procurement of long-lead equipment requirements.

Senator **Warner**. Your budget data indicates you may get a Phase 3 request for the LoADS warhead in fiscal year 1983. What would that mean in terms of budget requirements?

Mr. **Roser**. When the Phase 3 agreement is reached to proceed with development of the LoADS system warhead, the $16.3 million requested under Project 83-D-134 will be obligated to begin work on the necessary warhead production facilities. This is the only funding required in fiscal year 1983 for the LoADS system.

### SM-2 WARHEAD

Senator **Warner**. [Deleted.]

Mr. **Roser**. [Deleted.]

Senator **Warner**. You have a project, 83-D-124, for $7 million to begin facilities for this warhead. Why do you need money this year? When do you plan to put the warhead into production?

Mr. **Roser**. Project 83-D-124, Standard Missile (SM-2) warhead production facilities, various locations, will provide building modifications and additional equipment required to produce the SM-2 warhead. The requested fiscal year 1983 funding is needed for engineering design and for equipment procurement. This work must begin in fiscal year 1983 in order to meet the desired weapons delivery dates. [Deleted.]

## NUCLEAR WEAPONS STOCKPILE SIZE

Senator **Warner**. I would like to get the latest information on the size of the U.S. nuclear stockpile versus that of the Soviet Union. For the U.S., can you provide a chart showing stockpile yield (total megatonnage) and numbers of warheads over time (through the period of the stockpile paper)?

Mr. **Roser**. See attached charts. [Charts deleted.]

Senator **Warner**. Can these charts be subdivided to show strategic, theater, and naval nuclear weapons components?

Mr. **Roser**. See attached charts. [Charts deleted.]

Senator **Warner**. Provide a comparable chart for the USSR.

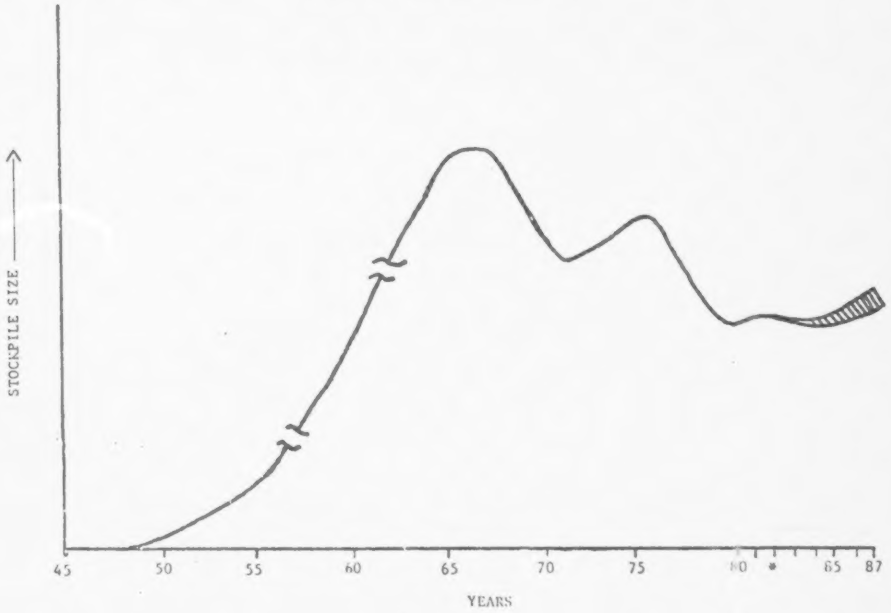
Mr. **Roser**. Comparable information about the Soviet nuclear weapons stockpile carries a classification which will not allow me to provide the information. This classification must be retained to prevent compromise of intelligence sources and methods. The authority to declassify such information is not within the jurisdiction of the DOE, but rather resides within the Central Intelligence Agency. [Deleted.]

Senator **Warner**. I would very much like to make this information available to the general public. Is there some way—perhaps if we took the numbers off the charts—that these charts can be declassified?

Mr. **Roser**. As you requested, we have reviewed our current classification policy in an effort to provide you with the information you desire. A formal declassification action has been initiated which allows the release of certain, qualitative information about the general trend of the size of our total stockpile of nuclear weapons. See the attached chart. However, the actual numbers involved are of such sensitivity that in the interests of the national security, they must retain their current classification.

Comparable information about the Soviet nuclear weapons stockpile must retain its classification as its release would compromise intelligence sources and methods. The authority to declassify such information is not within the jurisdiction of the DOE, but rather resides within the Central Intelligence Agency.

TOTAL WEAPONS IN STOCKPILE



### DOE REORGANIZATION

Senator **Warner**. You have a brief comment on the DOE reorganization in your prepared statement. Where does that reorganization effort stand?

Mr. **Roser**. The Administration is currently in discussion with the leadership of the concerned committees of Congress regarding jurisdictional issues and has not as yet submitted legislation. However, the Administration intends to submit such legislation during this session of the Congress.

Senator **Warner**. What happens to your Defense Programs under this reorganization plan?

Mr. **Roser**. Defense Programs would be transferred to the Department of Commerce along with most of the energy research related DOE programs.

Senator **Warner**. I realize you must support the President's proposal, but I would like to elicit your personal opinion on this reorganization. If you had the freedom to control the DOE reorganization, what type of reorganization would you propose?

Mr. **Roser**. I believe the nation would be adequately served by a revised Department of Commerce organization that included the nuclear defense programs and energy research functions. However, there are other alternatives if the DOE is to be dismantled, some of which have attractive features for Defense Programs, though they may not be regarded as consistent with the best organization of the Executive Branch as a whole. In any event, the nuclear defense program complex should be kept under a single point of high-level management within any new agency. The nation's best interest would not be served, in my opinion, nor could the defense responsibilities imposed by the Atomic Energy Act be effectively discharged, without such special focus and control by high-level, knowledgeable authority in the important agency in which the nuclear defense mission be lodged.

Senator **Warner**. Under the present reorganization proposal, do you think that Defense Programs are better off or worse off than they are now?

Mr. **Roser**. In the latest draft proposed Department of Commerce reorganization that we have seen, there appears to be no degradation in the stature of nuclear defense programs. There does appear to be a special focus for Defense Programs at a high level.

### INFLATION RATES

Senator **Warner**. The Defense Department was permitted this year for the first time to use inflation rates in their [illegible] calculations, specifically developed for and applicable to defense weapons [illegible] For the first time, we have some confidence that the Defense budget ref[illegible]tic rates of inflation. In developing your budget, what rates of inflation [illegible] assume, and what is the source of those inflation rates?

Mr. **Roser**. The escalation rates contained in the fiscal year 1983 budget request represent a composite of site-specific estimates of anticipated rates for labor, utilities, materials and supplies. The sites perform a detailed analysis of current commercial indices and historical trends to develop an average escalation rate weighted by the amount of their budget spent on the various functions, salaries, power, supplies, etc. Such indicators as the Producers' Price Index and the Consumers' Price Index were used in development of the rates. A weighted inflation function is then developed for each program. In Defense Programs, we are experiencing inflation rates of the chemical and nuclear industries which are higher than the national average. Our composite average across the fiscal year 1983 Defense Programs budget is 9.4 percent.

Senator **Warner**. Do you consider your inflation rates to be realistic?

Mr. **Roser**. If the current trend of reduced inflation rates holds, the allowances we have used should be adequate.

### W–87, ABRV WARHEAD

Senator **Warner**. [Deleted.]

Mr. **Roser**. [Deleted.]

### REPLACEMENT PRODUCTION REACTOR

Senator **Warner**. Are you convinced that we need to build one or more new replacement production reactors?

Mr. **Roser**. There is a need to design and construct a New Production Reactor (NPR) to insure that the Nation continues to have a sufficient and reliable supply of tritium for defense purposes. Such a reactor would also be capable of producing plutonium and other isotopes required by the weapons program.

The continued production of tritium is, and will remain, vital to maintaining the nuclear weapons stockpile. Since tritium has a half-life of 12.3 years, the tritium inventory decays at the rate of 5.5 percent per year. [Deleted.]

To meet the weapons program requirements, tritium is produced in large nuclear reactors at the Savannah River Plant. [Deleted.] The technology for coproduction of tritium and plutonium has also been demonstrated in the N Reactor at the Hanford site near Richland, Washington. No tritium is now being produced nor is tritium production currently planned in this reactor. Further, the N Reactor may not continue operation beyond the early 1990's because of radiation effects on its graphite moderator. Although specific failure mechanisms that would limit the lifetimes of the production reactors at the Savannah River Plant have not been identified, these facilities are now about 27 years old. Since it would be approximately 8–10 years before a new reactor could be designed, constructed, and put into a production mode, the Savannah River reactors will be the primary source of tritium until they are about 40 years old. Because these types of facilities typically have a finite lifetime, there is an increasing probability with age that they will become unavailable.

Senator **Warner**. What are your plans now with regard to such replacement reactor—when will you get started, how much will it cost, etc.?

Mr. **Roser**. An evaluation study has been performed to develop a technical basis for selecting among potential concepts. These efforts are aimed toward the selection of a concept and site during early fiscal year 1983. This schedule is consistent with a startup date in the early 1990's.

A new production reactor and associated fuel cycle facilities would cost between 3 and 6 billion dollars in fiscal year 1982 dollars depending on the type of reactor selected.

Senator **Warner**. What are the optional sites for a new reactor and do you personally favor a single site at this point in time?

Mr. **Roser**. No decision has been made on a site for the NPR. Currently activities are underway to evaluate the differences between potential sites. These activities should result in a recommendation for a site during early fiscal year 1983.

There are three sites currently under consideration for the NPR. Each of these sites is presently involved in defense programs activities. The sites are: Hanford Production Site, Idaho National Engineering Laboratory, Savannah River Production Site.

### L REACTOR COST ESTIMATE

Senator **Warner**. What has been the increase in total estimated cost for startup of the L Reactor since the program was initiated in fiscal year 1981?

Mr. **Roser**. The effort to upgrade L Reactor to the equivalent status of the three operating reactors at Savannah River began in fiscal year 1981. At that time, the preliminary cost estimate for the L Reactor upgrade was $184 million. The total estimated cost for construction was $115 million and other project-related costs were estimated at $69 million.

In December 1981, the total estimated cost for construction was revised to $134 million and the operating costs for other project-related expenses were reduced to $50 million, while the total estimated cost remained at $184 million.

A proposed firm L Reactor upgrade cost estimate became available on March 30, 1982. This estimate is still under review within DOE; however, Defense Programs expects to manage capital cost within the $134 million TEC identified in December 1981. Other project-related operating costs which were shown as $50 million in December 1981 are presently estimated to be approximately $80 million.

This $30 million cost increase is primarily due to incremental increases in a number of areas of the work associated with preparation of L Reactor for restart. The areas of increase are:

| | *Millions* |
|---|---|
| Additional testing and checkout of systems and subsystems | $4.5 |
| Training of reactor operators | 5.5 |
| Repairs to railroads | 1.2 |
| Charge and discharge machine renovation and repair | 2.2 |
| Disassembly basin repair and renovation | 4.2 |
| Heavy water purification system repair and renovation | 3.0 |
| Electrical cable replacement | 2.0 |
| Repair valves and piping for cooling water, domestic water and sanitary sewer systems | 3.2 |
| Motor control repair/replacement | 0.6 |
| Total | 26.4 |

The incremental increases resulted from the detailed inspection and testing that occurred in L area between October 1980 and January 1982. In addition, items recently identified by detailed engineering tests are:

| | *Millions* |
|---|---|
| Remove asbestos insulation | $0.4 |
| Dismantle powerhouse remains | .3 |
| Remove residue from reactor tank | .8 |
| Replace 600 transducer valves | .5 |
| Replace drainline to retention basin | 1.6 |
| Total | 3.6 |

Issuance of a firm cost estimate, an updated schedule for the L reactor upgrade, and the project management plan is planned for May 1982.

Senator WARNER. Again, speaking on behalf of the Senate and the people of the United States, we are grateful for your willingness to stay on and take on this very important assignment.

Admiral McKEE. Thank you, sir. I am grateful for the opportunity.

[Whereupon, at 1 p.m., the subcommittee was adjourned, subject to call of the Chair.]

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